For Editorial Contents see page 505

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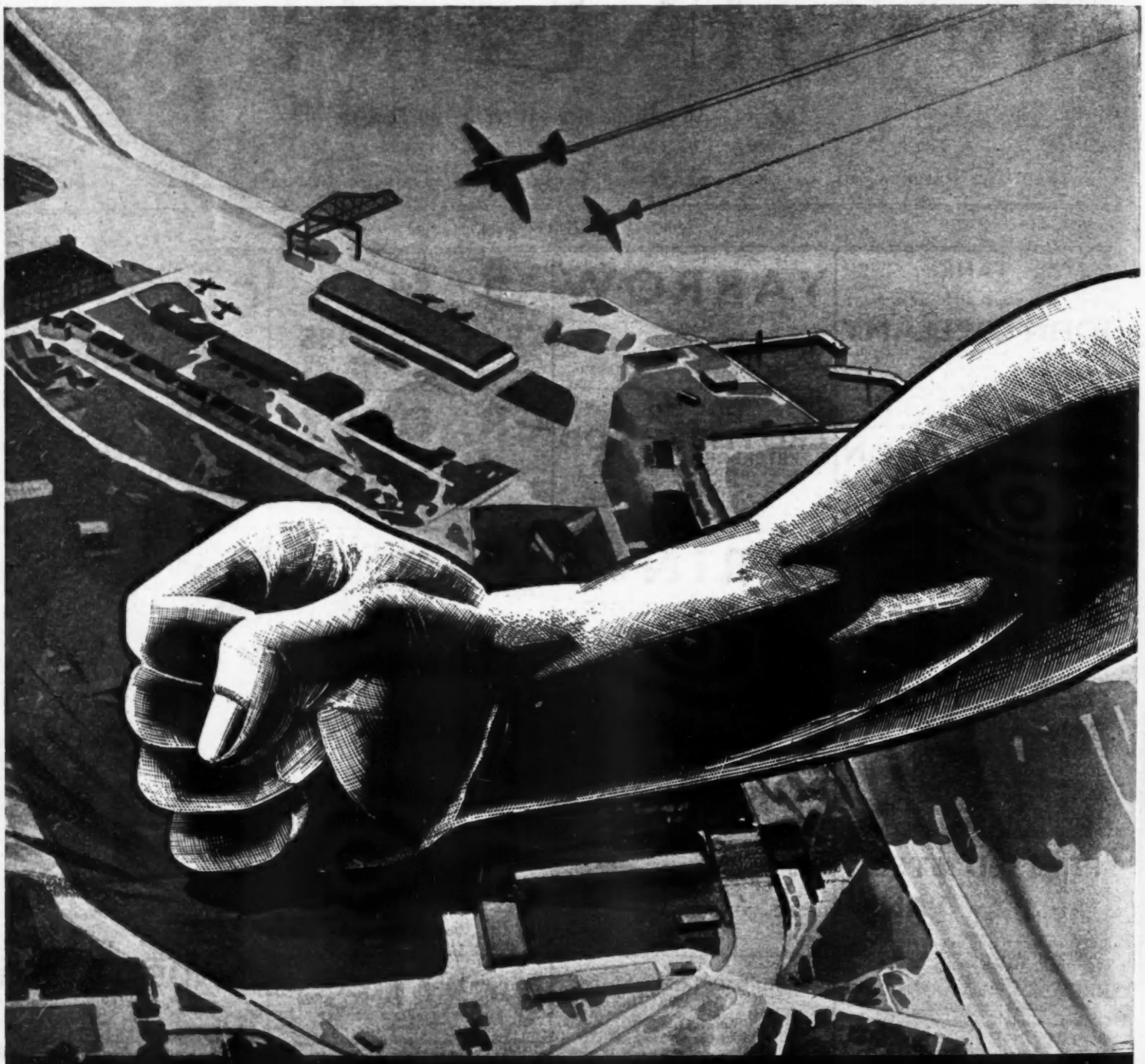

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THE CHILCOTE PUMPING STATION AND SOFTENING PLANT OF THE SOUTH STAFFORDSHIRE WATER-WORKS COMPANY.

(*Concluded from page* 454.)

EACH of the lime-storage tanks, referred to at the end of the previous article, contains enough cream of lime to keep the plant in operation for 16 hours at the maximum rate anticipated of 2,000,000 gallons per day. There are two storage tanks and each is fitted with agitators revolving in a vertical plane, to ensure that the cream of lime is kept in a state of constant density, thereby rendering the treatment of the water uniform. The agitators are driven by electric motors mounted on the outsides of the storage tanks and suitable access and inspection doors are provided on each tank. Drains and washout valves are also fitted. The cream of lime is drawn from the storage tanks by two centrifugal pumps, driven by electric motors and raised to lime-measuring equipment, in duplicate, erected in the operating room at the top of the staircase on the roof of the deposition tank. Each set of lime-measuring apparatus, illustrated in Fig. 24, on page 496, is mounted on a pedestal about 5 ft. high, and consists of a tank, in which is maintained a constant depth of cream of lime, the tank being fitted with an adjustable weir or orifice by which the amount of lime delivered is controlled. The actual control is effected from the filter house and from the lime-storage or preparing room; the quantity of lime delivered is under electrical control and is varied by the movement of a small switch. There is a constant depth of cream of lime in the measuring chamber, and, in fact, a portion of the cream of lime is in continuous circulation, being lifted from the lime-storage tanks in the lime-storage room to the measuring apparatus, and that portion which is not required for water treatment finds its way through an overflow pipe back to the storage tanks again. By this means, deposition of the lime in the measuring apparatus is avoided. Experiments in the softening of the water indicated that the presence of a relatively large proportion of magnesium salts necessitated the use of sodium aluminate. Provision is also made for the addition of sulphate of alumina if required. Two dry feed machines, shown in Fig. 20, on this page, are provided. These machines can be used, either both for sodium aluminate, both for sulphate of alumina, or one for each reagent. The machines are practically identical in their fittings and are located in the same room as the lime-cream storage tanks. They are driven by electric motors and the solutions, formed by the discharge of the reagents from the machines into small dissolving chambers, are lifted to the points of application by ejectors operated by small centrifugal pumps. The adjustment of the dose of sodium aluminate or sulphate of alumina is effected by setting the milled knob on the output control of the dry feed machine. The control of the lime is through an electrical device which increases or reduces the quantity of cream of lime delivered to the water, depending upon the hardness of the water and the quantity being pumped at any particular time. The sodium aluminate is delivered in steel containers, and a small electrically-operated lift is provided for raising the containers from the lorries to the floor of the storage room. The reagents are stored on the first floor of the chemical house, immediately above the lime-cream storage room.

The water collected in the channels at the top of the deposition tank is conducted into the annular tank for treatment with carbon dioxide. The carbon dioxide is produced in two stoves, situated at the end of one of the wings of the filter house, as shown in Fig. 7, Plate XXIV, *ante*. These stoves are fed with metallurgical coke, and pipes conduct the gas delivered from them through coolers. From the coolers, the gas passes through further pipes to the top of the access house, where they are connected to an ejector. The ejector is operated by softened water lifted by centrifugal pumps, two in number, placed at the bottom of the access house. This relatively small quantity of water containing the CO_2 is injected into the whole volume of water which is delivered into the annular tank from the deposition tank. Suitable means are provided to promote intimate admixture of the CO_2 with the decanted water from the deposition tank, and it is compelled to flow round the annular tank, which is covered by a concrete roof, to the outlet pipe situated near the access house, on the top of which pipe there is a throttling valve controlled by a float. The pipe conducts the water to the filters; and the valve prevents air being drawn into the pipe and so into the filters, thereby preventing any interference with the smooth operation of the filters. The CO_2 contact tank is sufficiently large to enable the chemical reactions to be completed, and, in course of time, there will probably be a small deposit of precipitate in this tank. To remove it, provision is made for four waste valves, to the outlets of which pipes are fitted, running vertically down the outside of the deposition tank to below ground level, thence to the waste-water tank. Two valves are provided, one in the mixing chamber and the other for sludge from the channels, both being connected to the filter waste main, which discharges into the waste-water tanks.

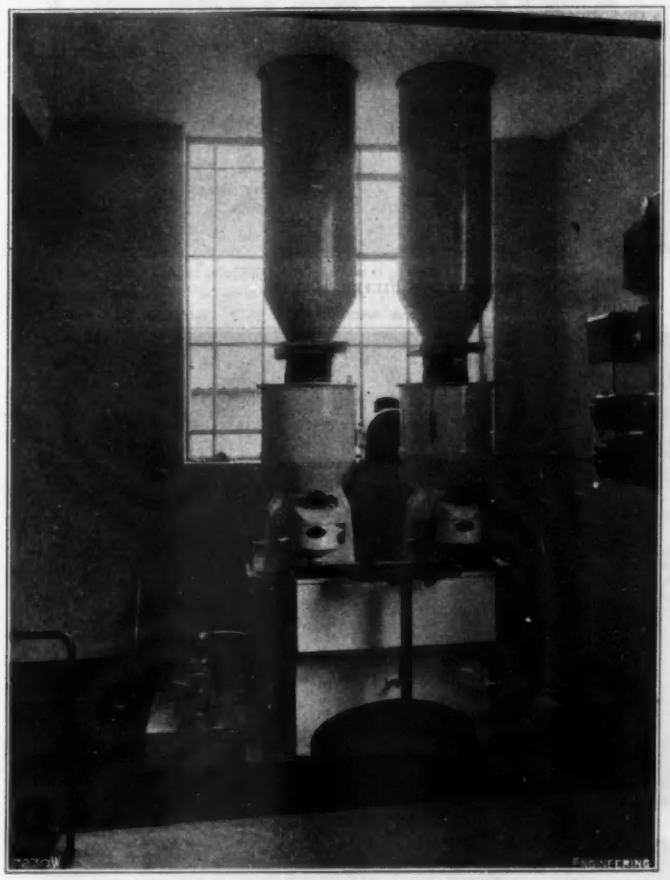

FIG. 20. DRY FEED MACHINES.

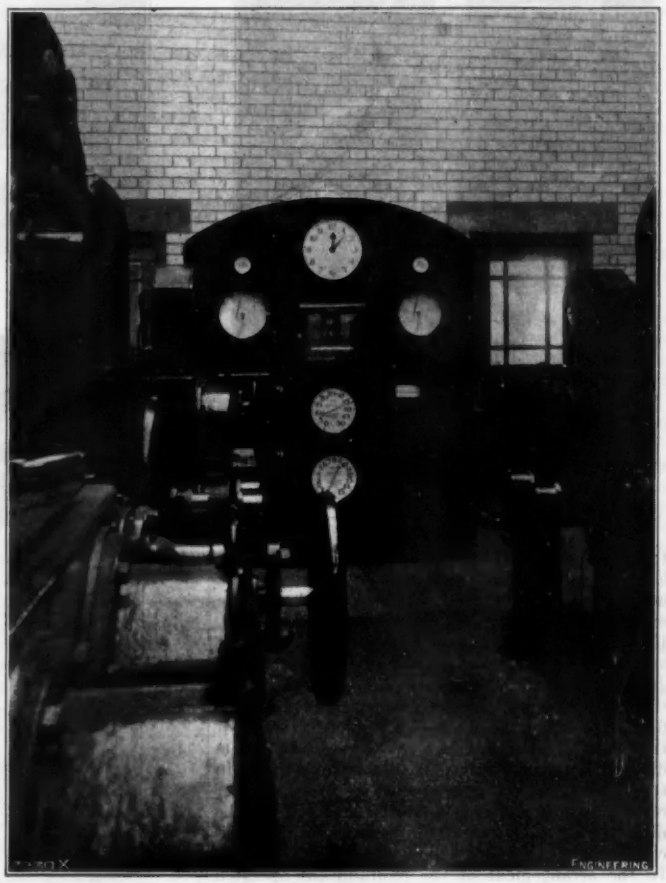

FIG. 21. CONTROL PANEL.

The heating of the filter house and offices is effected by a coke-fed boiler and hot-water pipes. The coke for the CO_2 stoves and for the heating boiler is stored near the stoves. The store is provided with a steeply-sloping floor so that the coke will fall readily to the stoking space. The walls of this building are open for several feet at the top in order to give free circulation of air, and assist in the dissipation of the heat produced by the CO_2 stoves. A roller-blind shutter is provided at the point where the coke is delivered from the lorries. The stoves themselves are fixed under a veranda-like roof, in a pit sunk below the general floor level of the building, with convenient access for stoking and cleaning.

Twelve filters are provided for dealing with

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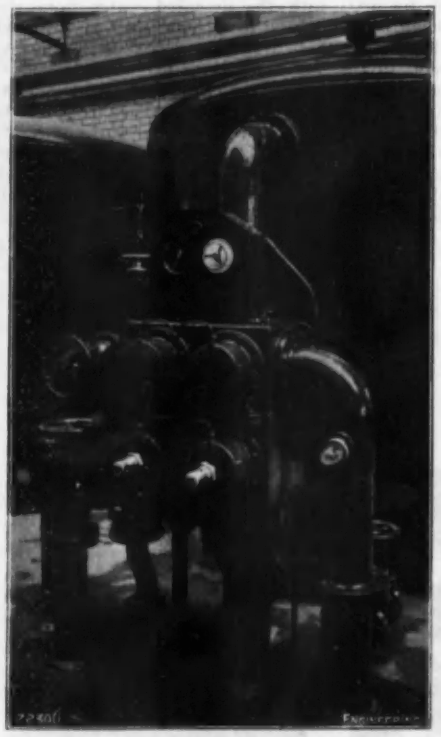


Fig. 22. Control Valves on Filter.

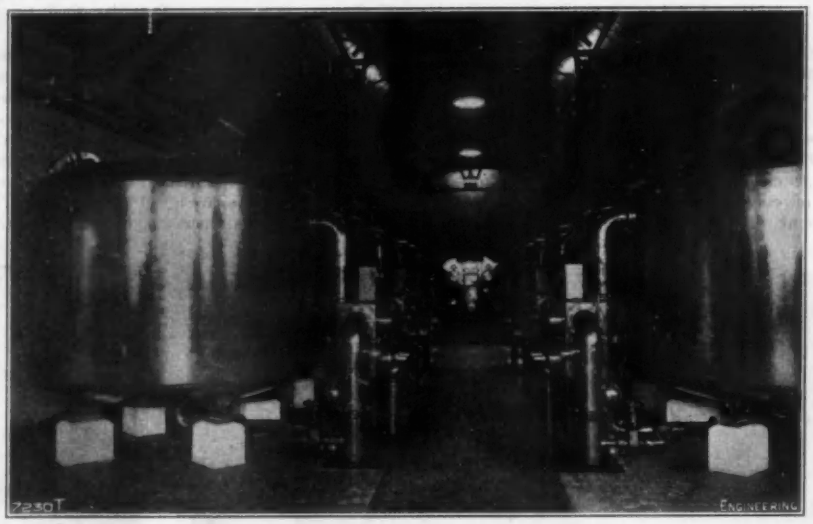


Fig. 23. Interior of Filter House.

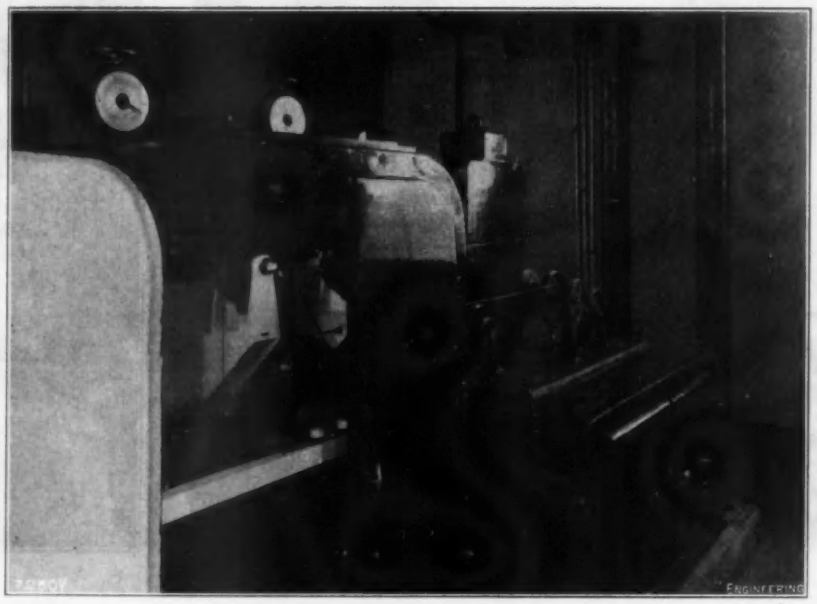


Fig. 24. Lime-Measuring Apparatus.

1,500,000 gallons of water a day. Space has been left in the filter house, which is shown in Fig. 23, herewith, for two additional filters, which may be required if the capacity of the plant is increased. Each filter is 8 ft. in diameter, and contains a bed of specially-graded sand supported upon underbeds of graded gravel of various sizes. The inlet pipe from the deposition tank passes under the floor of the filter house and connections are made to each of the filter inlets. The water leaving the filters discharges into another pipe in the same trench in the filter house, and is conducted to the pure-water receiving tank some few yards in front of the filter house. The filters are operated by hydraulically-operated valves, shown in Fig. 22, above. In the arrangement of the hydraulically-operated valves, each of the main valves in front of the filter is fitted with a hydraulic cylinder, fed with pressure water taken from the high-pressure supply through a reducing valve. Control of the valves is obtained by hydraulic switches fixed on a panel mounted on the front of each filter. This system of operating the plant reduces the manual labour to a minimum and renders the control extremely simple. Manually-operated valves are provided for the air inlets and by-pass water outlets. The filter beds are cleansed by agitating them with air supplied by duplicate blowers, each blower being driven by an electric motor. A hand-operated lever is provided on each of the filters so that the attendant need not move from the filter to start the blower; all the operations are carried out while he stands in front of the filter being washed. After the air has been admitted for two or three minutes, it is stopped by the hand-operated lever, and the wash water is admitted from the wash-water storage tank erected in front of the filter house. The filters are provided with rate of flow indicators, showing the number of gallons of water per hour passing through them, and also indicating the correct rate at which wash water should be supplied. Each filter is also fitted with a clarity indicator, so that the attendant will know when the washing operation is completed. The waste water from the filters is delivered into a main pipe in the trench beneath the filter house floor, and is conducted to the waste-water recovery tank. A panel, shown in Fig. 21, page 495, is provided at the end of the filter house near the laboratory. On this panel are placed the dial of a Venturi meter indicating the quantity of water discharged by the borehole pumps to the deposition tank, apparatus showing the percentage of CO_2 contained in the gases drawn from the stoves, and a meter indicating the quantity of CO_2 injected into the water. There are two pressure gauges on the same panel, showing, respectively, the pressures in the inlet and outlet mains in the filter house, as well as a recorder, giving a chart record of the *p*H value of the water leaving the plant. At the end of the filter house there is a small float chamber, above which is fixed a Paterson Fluxograph, arranged so that it measures all the waste water going into the waste-water sedimentation tanks. The wastes deliver over a weir at the entrance to the tanks, but the record of the discharge is shown on the Fluxograph in the filter house. The wastes include the wash water ejected from the filters, scourings from the mixing chamber at the entrance to the deposition tank, scourings from the CO_2 contact tank, and waste water used for washing the lime preparing and measuring plant. The water delivered into the waste-water sedimentation tank is allowed to remain until the bulk of the precipitate has settled out. The supernatent liquid is then lifted by a centrifugal pump to the deposition tank and afterwards passed again through the filters. The precipitated sludge is delivered by the same pump to the disposal area. The capacity of the tanks is 30,000 gallons.

The softening process produces a fairly large quantity of a white precipitate, consisting almost entirely of calcium carbonate in a very finely-divided state, but also containing the iron and manganese in the water. A record of the amount of water discharged from the deposition tank is obtainable by introducing a Venturi meter. The sludge-outlet pipe from the deposition tank is provided with branches from which connections are taken to the lagoons provided for the settlement of the sludge. The whole of the pumping plant was supplied and erected by Messrs. Mather and Platt, Limited, Manchester, their sub-contractors being Messrs. The English Electric Company for the electrical equipment. Messrs. The Paterson Engineering Company, Limited, of London, were responsible for the softening plant. The whole scheme was designed and carried out by the Company's Engineer-in-Chief, Mr. Fred. J. Dixon, M.Inst.C.E., M.I.Mech.E.

THE MARKETS OF LATIN AMERICA.

APART from the British Empire itself, there is no country or group of countries in the development of which British capital has been so intimately concerned as it has been in South America. The pioneer efforts of British engineers and financiers have left tangible evidence of the high standard of development attained, particularly by the agricultural and pastoral industries, and in the transport systems, which, in the first place, made possible the establishment of such industries on so large a scale, and, secondly, have administered so consistently to their growth. The phenomenal commercial development of South America has taken place principally during the past fifty years or so, and the total of British capital invested in Latin America is estimated to approximate the enormous sum of 1,128,000,000*l.* sterling, of which about 430,000,000*l.* is invested in Argentina (including 260,000,000*l.* in the railways alone), and 261,000,000*l.* in Brazil.

Assisted, therefore, by many years of close commercial and financial relations, as well as unbroken friendship, Latin America normally constitutes a predominantly important overseas market for British goods—far outweighing, for example, the markets of South-Eastern Europe. Therefore, in British circles trading with South America, a warm welcome has been extended to the British Government's declared policy of fostering this country's vital export trade under war-time conditions, and special satisfaction has been afforded by the number of export groups so promptly established in various British industries as part of the Export Council's drive for expanding overseas trade. Later in this article, an explanation will be given of the unique opportunity at present afforded for a British export drive in South America, because of the virtual disappearance of the former intense competition from Germany owing to the naval blockade of that country. In order, however, to place the present position and outlook in South America in correct perspective, some general remarks may first be necessary, particularly as the importance and variety of the markets there may not be fully appreciated. The area known by the general title of "Latin America" stretches from Mexico to Cape Horn, is more than twice the size of Europe and about half the size of the whole British Empire. In it there are seventeen republics, each with its own economic characteristics and monetary system, all in different stages of development; but all, with the exception of Brazil, where Portuguese is the national tongue, having in common the Spanish language.

The resources of Latin America are closely linked with the great variety of physical characteristics, the chain of the Andes mountains dividing the continent into two parts of unequal size and of sharply contrasting features. The eastern part, which is very much the larger, embraces great areas of tropical forests and river country, as well as immense expanses of fertile plains and pasture lands, and it is in this area that the great agricultural industries, such as the farming activities of the River Plate region and Patagonia, and coffee and cotton growing in Brazil, have been built up. To the west of the Andes lies mainly the narrow strip of Chilean territory, with a coast-line of more than 2,600 miles, and a greatest width of only 250 miles. Chile is rich in nitrate of soda, the most valuable natural fertiliser, as well as in copper and mineral deposits. The agricultural industries, also, are making steady progress. North-east lies the land-locked republic of Bolivia, which is the world's second largest producer of tin and possesses rich deposits of other metals, as well as extensive agricultural and pastoral areas. Farther north lie Peru, Ecuador and Colombia, all mountainous territories rich in agricultural and mineral resources, and Venezuela, with its invaluable oil deposits. Beyond the Isthmus of Panama lie the Central American "coffee states," and next, the republic of Mexico. The latter country, however, because of its intensely nationalistic policy and close relations with the United States' market, must be ruled out as a possible increased outlet for British goods. The cities of South America are famous—Rio de Janeiro and São Paulo, Buenos Aires (the Paris of the southern hemisphere), Santiago and Valparaiso and Lima (the old Spanish capital)—all of which are progressive and modern in every sense, and offer a striking contrast to the hundreds of thousands of square miles of open and often undeveloped territory which lie within the frontiers of the various states.

In order to assess the approximate overseas trading position of the South American countries, they may be divided roughly into two main groups, on the basis that South American economy depends upon the ready marketing abroad at remunerative prices of certain primary products derived mainly from the farming and mining industries. The first group embraces the River Plate countries of Argentina and Uruguay. The farming development which made the former country the wealthiest in South America did not occur until the last quarter of the past century; now the River Plate area constitutes one of the chief granaries of the world and as, in normal times, the grain and meat products of that area find a ready sale in Europe—particularly in Britain—it has been found possible to escape the necessity of submitting to German trading penetration through that country's "compensation" system. The countries of the second main group, however, comprising Brazil, Chile, Peru and most of the states of northern South America and of Central America, were often in a state of overproduction in certain commodities (such as coffee in Brazil and Central America, and nitrate, copper, etc., in Chile), and it was in these countries that, for some years before the present war, Germany was able to institute "compensation," or barter trading. This was done by offering a market for the products of the countries mentioned, which were paid for in specially-depreciated German export currency called *Aski* marks, which could only be used reciprocally in the purchase of German manufactures. This system was supported by direct German Government subsidies to the manufacturers, and, although unpopular in South America, enabled Germany to expand her trade enormously there, almost entirely at the expense of Great Britain. Both Britain and Germany lost a large part of their export trade to Latin America during the World War period, while the United States' exports to those countries increased. In the interim, however, until the outbreak of the present war, Germany had largely regained ground in Latin America, while Great Britain continued to lose markets there. This is shown by the comparison in Table I, herewith, of the percentages of all imports into Latin America, from each of the three countries, in 1913, 1933 and 1937.

TABLE I.—*Imports into Latin America.*

	1913.	1933.	1937.
United States	25·0	29·2	34·9
Germany	16·1	11·5	15·5
Great Britain	24·4	18·1	13·2

For reasons already mentioned, Britain retained her supremacy in the import markets in Argentina, but the lamentable story of the loss of British trade in Brazil, Chile and Peru, side by side with the expansion of Germany's trade, is told so clearly in the further comparative statement in Table II that no additional comment is required.

German "compensation" business with South America reached its zenith in 1937 and 1938, and the details given in Table III, on this page, of the imports of engineering and allied products in those years, show the secondary position held by Britain compared with Germany. The Argentine market is again excepted.

Before the outbreak of war last September, therefore, British trade losses with virtually every South American country other than Argentina had already become so serious as to cause various proposals to be advanced to check the deterioration. The position was aggravated by internal difficulties in the South American countries themselves, where, owing to economic problems resulting from the low level of commodity prices for some years following the international crisis of 1931, control of exchange and importation had been imposed in endeavours to restore the balance of payments. To some extent, the loss of trade with South America may have been due to misunderstandings on the part of British exporters (such as an exaggerated idea of the difficulties of sterling remittances), as well as to lack of propaganda and of the up-to-date sales methods demanded by the very competitive condition of the South American markets. It was realised, however, that Germany's strength lay in her centralised control of both exports and imports; in Britain, while a limited system of bulk exports through the medium of central industrial associations was not beyond our power, bulk import agreements were scarcely possible on a large scale in view of the limited extent to which the control of consumption is practicable in a democratic country in times of peace.

TABLE II.—*Trade with Principal South American Countries in* 1932 *and* 1938.

	Per Cent. of Total Imports from:		
	United States.	United Kingdom.	Germany.
Argentina, 1932 ..	13½	21½	9
1938 ..	17	20	10
Brazil, 1932	30	19	9
1938	24	10	25
Chile, 1932	25	13	15
1938	28	9½	26
Peru, 1932	27	17	9
1938	27	8	16

When war broke out, however, the whole position underwent a radical change. South America immediately benefited by the general increase in prices and the demand for primary commodities, a tendency which should become accentuated if the war be prolonged. Already, there has been a general improvement in the exchange values of the various South American currencies and a consequent easing in the remittance situation, as well as an inclination to remove restrictions upon imports. Because of the sea blockade of Germany, that country's trade with South America has virtually disappeared. German contractors are unable to complete their contracts in South America; as witness their inability to continue with the important Rio Negro hydro-electric scheme in Uruguay, which was destined to transform the whole position of power supply in that republic. The principal German exports to South America, namely, coal, the products of the heavy industries, iron and steel, and chemical products, can now be replaced by British exports. Already the British motor industry has set a good example in the war-time cultivation of export markets by increasing substantially the shipments of motor cars, etc., to South America.

TABLE III.

	United States.	Great Britain.	Germany.
Argentine Imports in 1937. (*£ Sterling.*)			
Fuel and lubricants ..	2,338,000	3,848,000	657,000
Iron and steel, and manufactures	894,000	1,784,000	2,693,000
Other metals and manufactures	760,000	1,633,000	650,000
Machinery and vehicles ..	5,866,000	1,412,000	1,592,000
Brazilian Imports in 1937. (*£ Gold.*)			
Coal	128,000	561,000	812,000
Transport material ..	2,060,000	696,000	689,000
Machinery and boilers ..	148,000	319,000	410,000
Iron and steel:			
Plates, bars, etc. ..	303,000	105,000	760,000
Tubes	76,000	78,000	358,000
Wire	138,000	7,500	382,000
Tinplates	455,000	138,000	264,000
Copper sheets, wire, etc.	119,000	90,000	120,000
Hardware, tools, etc. ..	126,000	152,000	231,000
Electrical material ..	236,000	83,000	231,000
Wireless apparatus ..	246,000	3,000	50,000
Oil and petrol motors ..	29,000	19,000	115,000
Chilean Imports in 1938. (*Pesos, 6d. Gold.*)			
Metals	17,913,000	4,300,000	28,031,000
Machinery, etc.	27,162,000	6,316,000	26,226,000
Transport material ..	28,844,000	11,126,000	18,900,000
Peruvian Imports in 1937. (*Soles.**)			
Machinery, tools, vehicles, etc.	34,792,000	5,205,000	8,733,000
Metals and manufactures	11,241,000	2,959,000	9,978,000
Electrical material ..	4,785,000	618,000	1,973,000

* 20 soles = 1*l.* sterling, approx.

Under war conditions, British import and export trade is officially controlled, and, while nothing resembling the German "compensation" system, with its undue regimentation, is contemplated, inevitably our overseas trade is being conducted on reciprocal bilateral lines, tending towards a system of exchange clearing in sterling. By reason, particularly, of the extent to which Germany had captured South American markets before the war by means of such artificial and unpopular methods as "compensation" treaties and subsidies, it is commendable that the British Export Council recognises that, the more the arrangements adopted for war export trade are built on the normal structure of trade, the sounder and healthier will be the state of the trading organism at the end of the war, when more critical and testing conditions are likely to be encountered.

It must be remembered that South American overseas trade is essentially reciprocal in nature, so that any expansion in demand for British goods depends largely upon the extent to which Britain can replace Germany and Central Europe as a market for South American products; already our export drive is being helped by the wider spread of the British Government's purchases of commodities among the South American countries. In addition to this, there is preference in Latin America for British goods and a very general sympathy with the Allied cause in the present war. It is fatal, however, to rely complacently on these advantages; British exporters must be prepared to quote prices and delivery and credit terms which are really competitive with those of other nations. The war-time rise in prices of British manufactures leads to the danger that South America may be compelled to obtain cheaper goods from competing countries; and orders are already being diverted to the local manufacturing industries, which have shown remarkable growth during recent years. It is encouraging, however, that the British Government, in close collaboration with trade organisations, is making every effort to ensure adequate supplies of raw materials to export industries, and to adjust prices to world levels. Meanwhile, the leading neutral countries, such as the United States and Italy, are making intensive efforts to fill the gap in South America's imports left by the virtual disappearance of German trade. One of the means being employed by the United States in their trade drive in South America is to grant credits through the Export-Import Bank of Washington to finance sales of American products, particularly capital goods; but any large expansion of loans of this nature is steadily assailed in important American quarters on political grounds. Nevertheless, although trade between the United States and Latin America since the war started has not reached the anticipated "boom" proportions, North American exports to the Southern Continent have undoubtedly shown a marked increase, mainly owing to the difficulties of exportation from Europe.

Prospects for British trade appear most bright in Argentina, where, following large purchases of foodstuffs by the Allies, the amount of sterling exchange at present available is more than sufficient to pay for imports from Britain. An official import-exchange permit is required for every shipment to Argentina, and by this system the Argentine Government is able to control the source and variety of imports, exchange permits being freely granted to Britain. The import system in Uruguay is somewhat similar to that in Argentina, and monthly import-exchange quotas are granted to various supplying countries, Britain usually obtaining the largest quota. In Brazil, with the improvement in the foreign-trade position, exchange cover for imports is smoothly forthcoming under permit, and shippers need have no fear of any "blocking" of their funds in Brazil. In Chile, too, permits are required for imports, and, in reciprocation for recent purchases of wool, meat, etc., by the British Government, there is a sufficient supply of sterling to pay for imports from this country. Peru has avoided exchange control; much attention is being paid to transport development, and, as Britain is the chief war-time market for Peruvian cotton, there is a tendency to turn to reciprocal trading with Britain, with a consequent good opportunity for a British trade drive.

In conclusion, it may be stated that, apart from war-time considerations, South America will require, for many years to come, heavy imports from abroad of general engineering material, railway equipment, tractors, etc., in order to open up the many thousands of square miles of unexploited territory. Extensive road-building programmes in the various republics are leading to an increased demand for motor-vehicles of every kind. Exporters should pay close attention, however, to the individual requirements of local markets, and to credit terms, current exchange regulations, etc. They should also familiarise themselves with customs and shipping regulations in the various republics, closely following consular instructions in this respect. Reference has been made to the importance of the price factor, and equal stress must be laid upon the utilisation of the most up-to-date sales methods. Correspondence, catalogues and other literature should be printed in Spanish, or in Portuguese in the case of Brazil, measurements, etc., being expressed preferably in metric units. Finally, a paramount consideration is the employment on the spot of a reliable agent or representative in close touch with Government, municipal, railway and other official and private quarters, from which requests for tenders and information are likely to emanate.

18-FT. DOUBLE-HEADED UNIVERSAL GEAR-HOBBING MACHINE.

WHILE, in describing the large double-headed universal hobbing machine illustrated in Figs. 1 to 13, on Plate XXVI and pages 499, 500 and 504, a discussion of the principles of the different methods of gear cutting is not necessary, some comment on two of them would seem to be desirable since confusion between the processes of hobbing and milling gear teeth is occasionally evident. Both processes employ a rotating cutter, as opposed to the reciprocating cutter of the so-called planer types of machine. The cutter of the milling machine consists of a single circle of blades formed to the contour of the tooth required. Only one tooth is cut at a time, the pinion, or gear wheel, to be dealt with being held stationary during the operation. The cutter of the hobbing machine consists of a helical arrangement of blades resembling, in some measure, a worm. The blades are usually straight-sided and have their edges lying at a predetermined pressure angle. As the cutter rotates, the pinion or gear wheel, must also rotate, so that the straight-edge blades generate teeth of involute contour. The hob may have its blades arranged in a helix of one thread, in which case it makes a single revolution in the time that the work rotates through an arc equal to that occupied by one tooth and one tooth-space, measured on the circumference of the pitch circle of the pinion or gear wheel concerned. Hobs with the blades arranged in two or more threads can also be employed, the generation of involute teeth proceeding as with the single-thread hob, though the work must rotate through two or more tooth widths and spaces for each revolution of the hob.

This somewhat elementary explanation will, it is considered, provide a key to the arrangement of the machine illustrated, which has been constructed by Messrs. The Power Plant Company, Limited, West Drayton, Middlesex. From the drawings, Figs. 1 and 2, Plate XXVI, and the photographs reproduced in Figs. 12 and 13, page 504, it will be clear that the rotating table on which the work is carried occupies the centre of the machine. The hobs, of which there are two, are mounted on saddles having vertical traverse on columns at each side of the table. The columns can be traversed longitudinally on the bed for setting to suit the diameter of the gear being cut. The hob axis can be set at an angle since, when cutting a plain spur gear, it is clear that the blades must be traversed vertically across the face of the gear, the amount of inclination of the hob spindle being equal to the helix angle of the hob, and the rate of traverse being the cutting feed. When helical gears are being generated the helix angle of the gear itself has also to be allowed for, so that the cut is parallel to the face of the teeth, the saddle traverse being, of course, vertical as before.

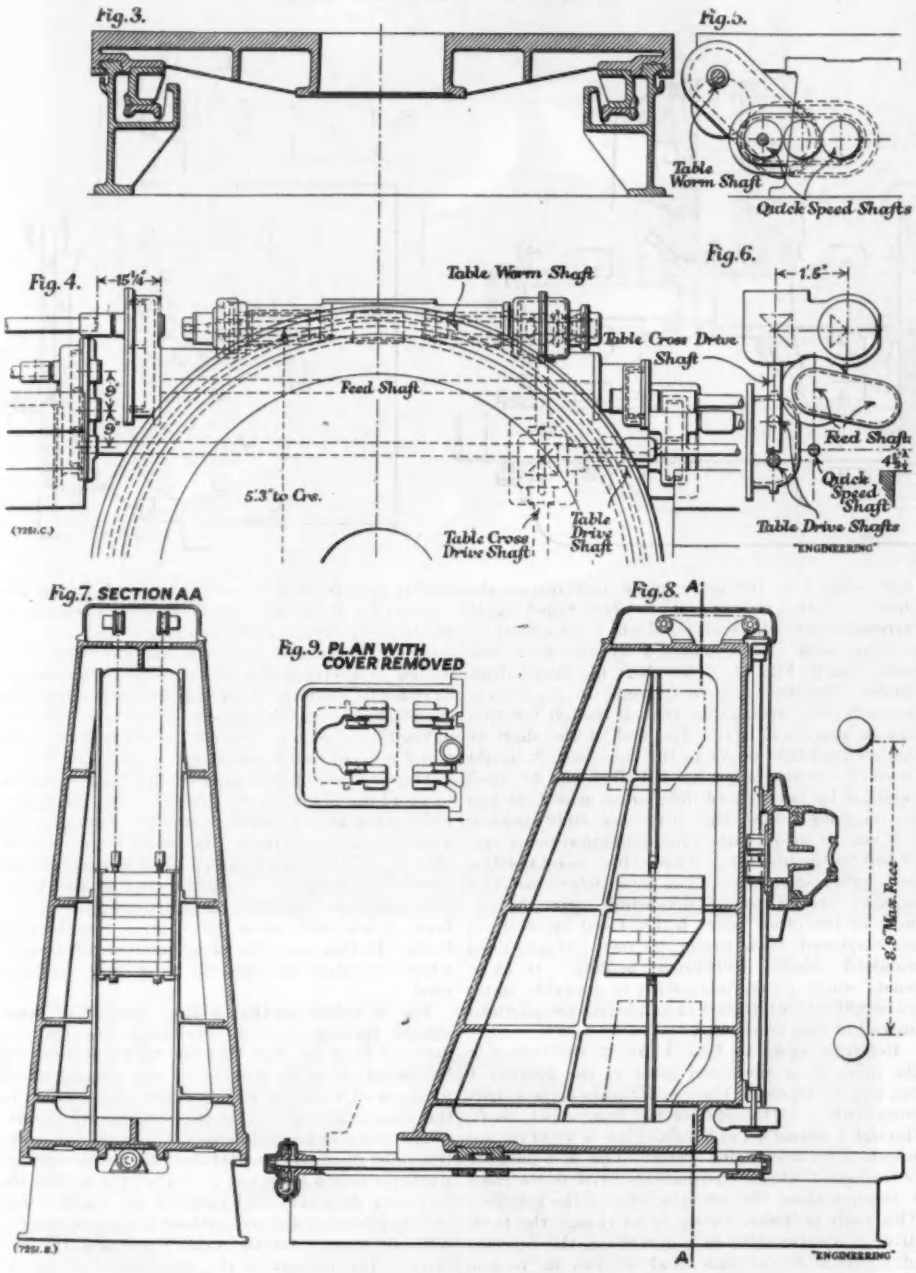
The hobs are shown with their spindles horizontal in Figs. 1 and 12, and are seen to be inclined in Fig. 13, in which view a pair of helical gears is being cut, the top gear by the hob on the left-hand column and the bottom gear by that on the right hand. Both hobs are also used simultaneously when single gears with double-helical, or "herring-bone," teeth are cut. When a worm wheel is being cut, the hob employed has the same form of tooth and is of the same diameter as the worm which has to mesh with the gear. The hob spindle is, therefore, set horizontally, that is, with its axis at right angles to the axis of the work, and the saddle is locked to its slide, and is not traversed vertically. The cutting feed is given by traversing the column longitudinally on the bed until the desired tooth depth has been reached. Only one of the columns, viz., that on the left-hand side in Figs. 1 and 12, is provided with this feeding traverse. The worm wheel being cut is rotated at a suitable rate as the hob is fed towards its axis. The views given in Figs. 1 and 12 show the front, or operator's side, of the machine, that given in Fig. 13 showing the opposite side, or back.

The machine, as indicated by the term "universal," can be used for cutting either single-helical gears, double-helical gears, ordinary spur gears, or worm gears of any diameter between 3 ft. 6 in. and 18 ft. on the pitch circle, the teeth being of involute contour and of any pitch up to 5 in. Either single-thread or multi-thread hobs can be used. The column traverse allows of hob centres between a minimum of 4 ft. and a maximum of 18 ft. 9 in. The face width of the gear that can be cut depends, naturally, on the setting of the hob spindles. When both spindles are horizontal the maximum face width is 8 ft. 9 in., but when they are set at an angle of 45 deg. the maximum is 8 ft. 3 in. In this connection it may be mentioned that the gear being cut in Fig. 13 has two faces, each 19½ in. wide, with a space of 22 in. between them, the total vertical distance between the two hob spindles being thus 5 ft. 1 in. The gear, which is for a marine installation, has a pitch-circle diameter of 103·805 in., with 283 teeth of 1 in. normal pitch and 1·152349 in. circular pitch. The helix angle is 29 deg., 56 min., 58 sec. A machine capable of dealing with work of the dimensions indicated is, in itself, of a very imposing size, its scale, indeed, may be recognised from the operator at the left hand of Fig. 13. The overall length is approximately 58 ft. 7 in., the overall width about 14 ft. 9 in., and the height, from the bottom of the main bed is 18 ft. 9 in. The actual height is, however, increased by a further 1 ft. 2 in. due to the recessing of the bed under the work table into the foundations.

The construction of the machine may now be considered in greater detail. The main bed consists of two rectangular members on which the columns are mounted, and between which is a circular bed carrying the rotating work-table. The rectangular beds are of deep box-girder cross section. There are four sliding ways for the columns on each bed, each way being 9 in. wide, less the width of a Tee-slot running down their centres. The Tee-slots are machined out of the casting and are provided for locking the columns in position. The ways are finished by careful scraping to accurate surface plates. The circular table bed is a strongly-ribbed casting of the section shown in Fig. 3, opposite, Figs. 4 to 6 on the same page giving some details of the table-driving gear. The table is carried, in the main, on a wide flat seating with a conical seating below it, this latter seating ensuring accurate centring and taking part of the weight. The top inner part of the bed is formed as an oil trough in which the indexing worm-wheel rotates in a submerged condition. The housings for the worms driving this wheel are cast integrally with the bed. A smaller trough on the external periphery of the bed receives the lubricant from the seating. It should be noted that this oil is supplied under pressure to both the horizontal and conical bearing surfaces, so that the table actually rotates on a film of oil and there is no metallic contact between the table and its seats when the machine is at work. The oil pressure automatically adjusts itself accord-

18-FT. UNIVERSAL GEAR-HOBBING MACHINE.

MESSRS. THE POWER PLANT COMPANY, LIMITED, WEST DRAYTON.



ing to the load on the table, and the upward thrust due to it is met by annular keep plates at the outer edge of the horizontal surface.

The table is of heavy section and is stiffly ribbed. It is 11 ft. 4 in. in diameter overall and has a central hole 26 in. in diameter. This hole is provided with a removable cover and accommodates the shaft flanges of such gears as are cut with the shaft in place. The surface of the table is finished with radial Tee-slots for securing the work, arranged as seen in Fig. 2. Referring again to Fig. 3, it will be seen that the index worm wheel is bolted and spigoted to the underside of the table. It is made of a special close-grained cast iron and has a pitch diameter of 10 ft. The wheel is split centrally in the horizontal plane, this method of construction being adopted in order to eliminate dividing errors in tooth pitch. The halves of the wheel were first bolted together and the teeth cut in this condition. They were then unbolted and rotated relatively to one another into several positions at each of which the teeth were re-cut, until a uniform pitch was secured, being finally bolted together again and firmly fixed by steady pins. The wheel teeth were cut by means of an unusually long hob having extra deep blades in order to ensure large bearing surfaces. The table-bearing surfaces and the faces of the indexing wheel were finish-turned in one setting to ensure parallelism.

Although the transmission of the main drive to the table will be considered later, it is convenient here to deal with its final stages, since these are shown in Figs. 4 to 6. It will be evident from Figs. 12 and 13, which show opposite sides of the machine, that the table is driven from both sides. One worm drive only appears in the partial plan, Fig. 4, but both are identical, except that they have axial adjustment in opposite directions, thus providing means for eliminating backlash. The adjusting device is arranged so that the axial movement does not change the position of the worm-driving gear, neither does it affect the adjustment of the ball thrust bearings which take the worm thrust. The axial adjustment is effected without opening the worm housings by simple operation of a pin key. The main table-drive shaft runs along the whole of the bedplate on the operator's side, as seen in Figs. 1 and 2, but, close to the table bed, it is brought nearer to the longitudinal centre line of the machine by a pair of gear wheels, as will be clear from Figs. 4 and 6. The short length of shaft thus required drives, through bevel gears, a cross shaft running under the table bed. The cross shaft finishes at each end with bevel gears, which transmit the drive to short vertical shafts, themselves terminating in another set of bevel gears driving the worm shafts. The worms rotate in opposite directions. The boxes containing the vertical shafts from the cross shaft to the worm shafts are clearly visible in Figs. 12 and 13.

The columns, shown in detail in Figs. 7 to 9, on this page, are of strong well-ribbed box section. They are 4 ft. wide across the face, on which the hob saddle slides, and the length of the base on the ways of the bed is 9 ft. 6 in., the large bearing surfaces for both motions thus provided ensuring complete rigidity. The columns are traversed along the bed by a screw 3½ in. in diameter, and having a right-hand ½-in. pitch Acme thread. As is evident in Fig. 8, the connection between the screw and the column is made by two separate nuts. These are of gunmetal and are adjustable one against the other, so that backlash is eliminated. When the working position of the columns on the bed is determined, they are clamped in position by means of eight bolts, 1¼ in. in diameter, in the Tee-slots of the ways. A micrometer device is provided for each column for setting them accurately for depth of cut. Indexing mechanism, consisting of scales and pointers, enables rapid re-setting to similar positions for repetition work to be effected. The nature of the guides on the ways of the bed will be apparent from Fig. 7, steel taper strips providing lateral adjustment for wear. The interior of the column is occupied by a weight which balances that of the hob saddle and is connected to the saddle by flat link chains. The weight is guided by a vertical channel on each side. The guide pulleys are protected by a removable cover on the top of the column.

An outline of the hob saddle is shown in Fig. 8. It consists of a sliding base, 4 ft. wide by 5 ft. long. There are two ways on the column, as shown in Fig. 9, lateral adjustment for wear being provided by two steel taper strips. Vertical traverse is effected by double nuts and a screw of the same size and type as that used for the horizontal traverse of the columns. This screw has a guaranteed accuracy of 0·01 in. in 6 ft., and is always in tension. The thrust on it is taken by heavy ball bearings. The sliding base of the saddle carries a swivelling member to which the hob spindle bearings are attached. The hob can thus be set with its axis lying at any angle up to 45 deg. in either direction, a dial indicator being provided for setting. The swivelling member is locked in position, when set, by means of the Tee-headed bolts seen in Fig. 8. Its base is of exceptionally large diameter and the hobbing gear is thus amply and rigidly supported. The hobbing gear is not shown in this illustration, but its arrangement may be gathered from Fig. 2. The hob is carried on an arbor lying between two bearings, both of which are capable of axial adjustment, so that hobs of different lengths may be supported to within a short distance of their actual cutting length. Hobs up to 14 in. in external diameter can be accommodated.

Referring to Fig. 2, the inner bearing, viz., that on the driving-spindle side, is of the double-cone type, and is, therefore, particularly well adapted to withstand axial stresses. This bearing supports one end of the hob spindle, while the outer bearing supports one end of the hob arbor. The outer bearing is of the single-cone type, and, assuming ordinary care is used in its adjustment, eliminates all possibility of slackness of the arbor in the bearings. The connection between the arbor and the spindle is as follows: The spindle nose has a taper hole into which the hob arbor enters. This hole, moreover, has longitudinal grooves with which corresponding tongues on the arbor engage. The arbor is screwed externally and a differential nut keeps the arbor and spindle in line. The nut does not transmit any torque, this being taken by the grooves and tongues, which also prevent axial

18-FT. DOUBLED-HEADED UNIVERSAL GEAR-HOBBING MACHINE.

MESSRS. THE POWER PLANT COMPANY, LIMITED, WEST DRAYTON.

Fig. 10.

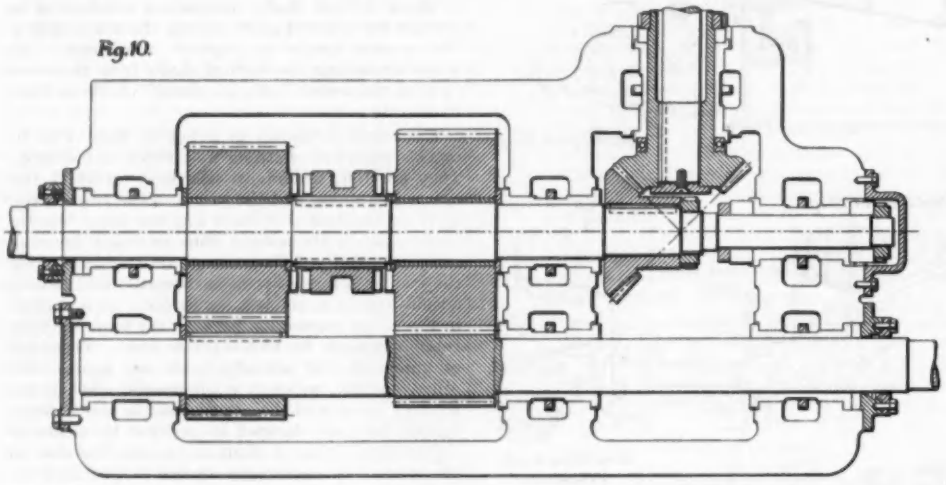
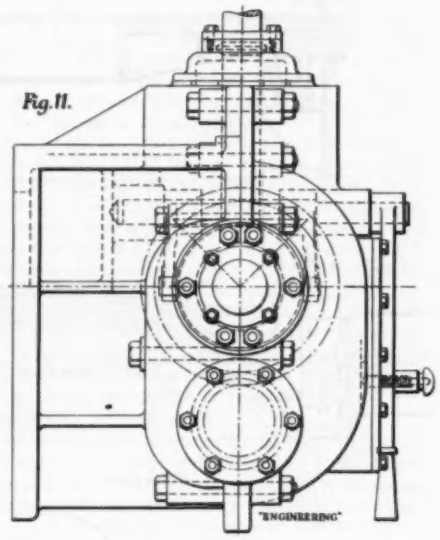


Fig. 11.



thrust being transmitted to the arbor bearing. The driving part of the hob spindle is 3½ in. in diameter. It is splined where it passes through the driving wheel, which is fitted with a cast-steel "Barth" type key. The spindle is of high-carbon steel accurately ground all over. The axial adjustment of the spindle through the wheel, to suit different lengths of hob, is made by a screw and nut on the inner bearing.

The several motions of the machine may now be considered. The whole of the operating motions are derived from a 35-h.p. variable-speed motor having a speed range from 400 r.p.m. to 1,200 r.p.m. The operating motions comprise: The rotation of the hob and work table and the vertical feed traverse of the hob saddle when spur or helical gears are being generated, and the horizontal feed traverse of one column when a worm wheel is being cut. Two setting motions are derived from a separate 12-h.p. motor with a speed range of from 600 r.p.m. to 1,200 r.p.m., these motions being the rapid traverse of the columns and the rapid traverse of the hob saddles. A small motor, of 2 h.p., drives two gear-wheel type pumps, one of which supplies the pressure oil to the table and the other the cutting lubricant to the hobs.

It will be appreciated from what has been said above, that the rotations of the work table and of the hobs must bear a definite relation to one another; not, of course, a fixed relation, but one which can be altered quantitatively as determined by the size and characteristics of the gears to be cut. This variable relation involves a system of boxes with sliding gears, epicyclic differential gears and change wheels. The feed traverse of the two hob saddles must be in opposite directions since, in generating a double-helical gear, one hob has to start from the top of the work and travel downwards while the other travels upwards from a starting cut at the bottom. Nevertheless, in spite of the apparent complications involved, all the operating motions are obtained in the most direct manner possible from the single main driving shaft, with the result that the gearing employed is reduced to the minimum.

The spindle of the main motor, indicated at *a* in Fig. 2, drives the pinions of a two-speed sliding gearbox *b*, the pinions meshing with gear wheels on the main drive shaft. The purpose of this gearbox is to provide alternative speed reductions from the motor drive, the ratio of the two gears being, respectively, 1 to 1·782 and 1 to 2·764. The gearbox is seen to the extreme left of Fig. 12, the projecting shaft being that taking the drive from the main motor, which is not included in the view. Two detailed views of the gearbox are given in Figs. 10 and 11, above. The lower shaft in Fig. 10 is that coupled to the main motor and carries the pinions of the reducing gear. The upper shaft carries the gear wheels either of which is engaged by a sliding dog clutch actuated by the lever and forks seen in Fig. 11. This shaft has two output points. The bevel gears on the right drive, speaking generally, the work table, though its full function will be described later. The end of the shaft at the left transmits power to the hobs, not, it should be noted, directly, as its line is broken and its speed modified by two sets of differential gears. It will be recognised that the gears are fully-enclosed and run in an oil bath, ring-lubrication being employed for the bearings. This is the general practice with other gearboxes. The gear wheels in this instance are of the double-helical type, but in most of the other boxes hollow-faced spiral gears are employed, each having its own self-contained standard double ball-thrust bearing. At those points where grease lubrication is desirable, automatic tell-tale lubricators of ample size are provided instead of ring lubrication.

Referring again to Figs. 1 and 2, the course of the drive from the bevel gears in the gearbox *b* can now be traced. These bevel gears drive a short cross-shaft *c* at the end of the bed, which shaft, through a second set of bevels, drives a set of change wheels *d* on a swinging frame. This last member of this set of wheels transmits the drive to the shaft *e*, running along the operating side of the machine. This shaft provides, among other things, the table drive and terminates in a gearbox *f*, the function of which is to continue, and reverse, its motion through the short shaft *g*, situated under the work table and terminating in a bevel drive to the shaft *h*. The latter, being below the work table, is below the plane of the table worm-shafts *i i*, and is furnished with a short vertical shaft at each end which, by means of bevel gears, forms the final link in the transmission to the table worm shafts. Other details of the drives in the region of the table will be clear from Figs. 3 to 6.

It will be noticed, from Fig. 1, that the main drive shaft *e* passes below a transmission gearbox *j*. The shaft *k*, which runs transversely through the bed of the machine, operates, through change wheels *l*, the spiralling differential indicated at *m*, and is driven from the feed motion. The motion of the feed shafts *n* and *n′* is derived from a sliding gear change box *o*, and a set of change wheels *p*. Consideration of the precise arrangement of the feed shafts may be deferred for the moment. The second transverse shaft *q* derives its motion directly from the table-drive shaft *e*, and drives, through change wheels *r*, the prime-number differential *s*.

Details of the differentials will also be dealt with later, but, at the moment, it may be noted that they modify the speed of the hob drive shaft *t* from the gearbox *b*. Both differentials transmit the drive to the hobs by means of the shafting *u* and *u′*. Two reference letters are used for this shafting, since its line is interrupted by a transmission gearbox *v* in order to clear the table drive, this transmission gear including an idler pinion, so that the direction of rotation of *u′* is not affected. The speed of both *u* and *u′* is, of course, the same.

The function of the prime-number differential is to avoid the necessity of providing a special change wheel when it is required to produce a gear having a prime number of teeth. It should be understood that neither the prime-number differential nor the spiralling differential is required when parallel-tooth spur gears are being cut, the only exception to this being when such gears have prime numbers of teeth. In this case, the prime-number differential, which is linked up with the table drive only, is used.

The hob-shaft motion is thus capable of being altered through a very wide range, as may be deduced from the fact that the table rotation can be varied so as to provide for the cutting of all numbers of teeth, including prime numbers up to the maximum capacity of the machine by the use of the prime-number differential. As the hob rotation must be in precise relation to the table rotation, whatever gear is being cut, it will be evident that the necessary flexibility and range of the machine has been ingeniously secured without having to employ different motors for the table drive and the hob drive. The motion of the hob shafts, *u* and *u′* is transferred to the hob gear through the sliding transmission gearboxes *w* and *w′*. The feed shaft *n* and its continuation *n′* have also sliding transmission gearboxes *x* and *x′*. The rapid power traversing shafts on the same side of the machine are indicated in Figs. 1 and 2, at *y*, *y′*, while the motor for providing this rapid power traverse is shown at *z*, the large handwheels seen at each end of the bed being for hand-power traverse.

(To be continued.)

PLANING MACHINE FOR MARINE PROPELLERS.

IT has been recognised for some time that the surface finish of a marine propeller is a factor in propulsive efficiency, and Messrs. The Manganese Bronze and Brass Company, Limited, Caxton House, Westminster, London, S.W.1, have always given careful attention to this requirement. This firm has now effected a further improvement in blade finishing by drawing up a specification for and installing a new machine, which is illustrated in Figs. 1 and 2, opposite, and has been constructed by Messrs. Morton Manufacturing

PLANING MACHINE FOR MARINE PROPELLERS.

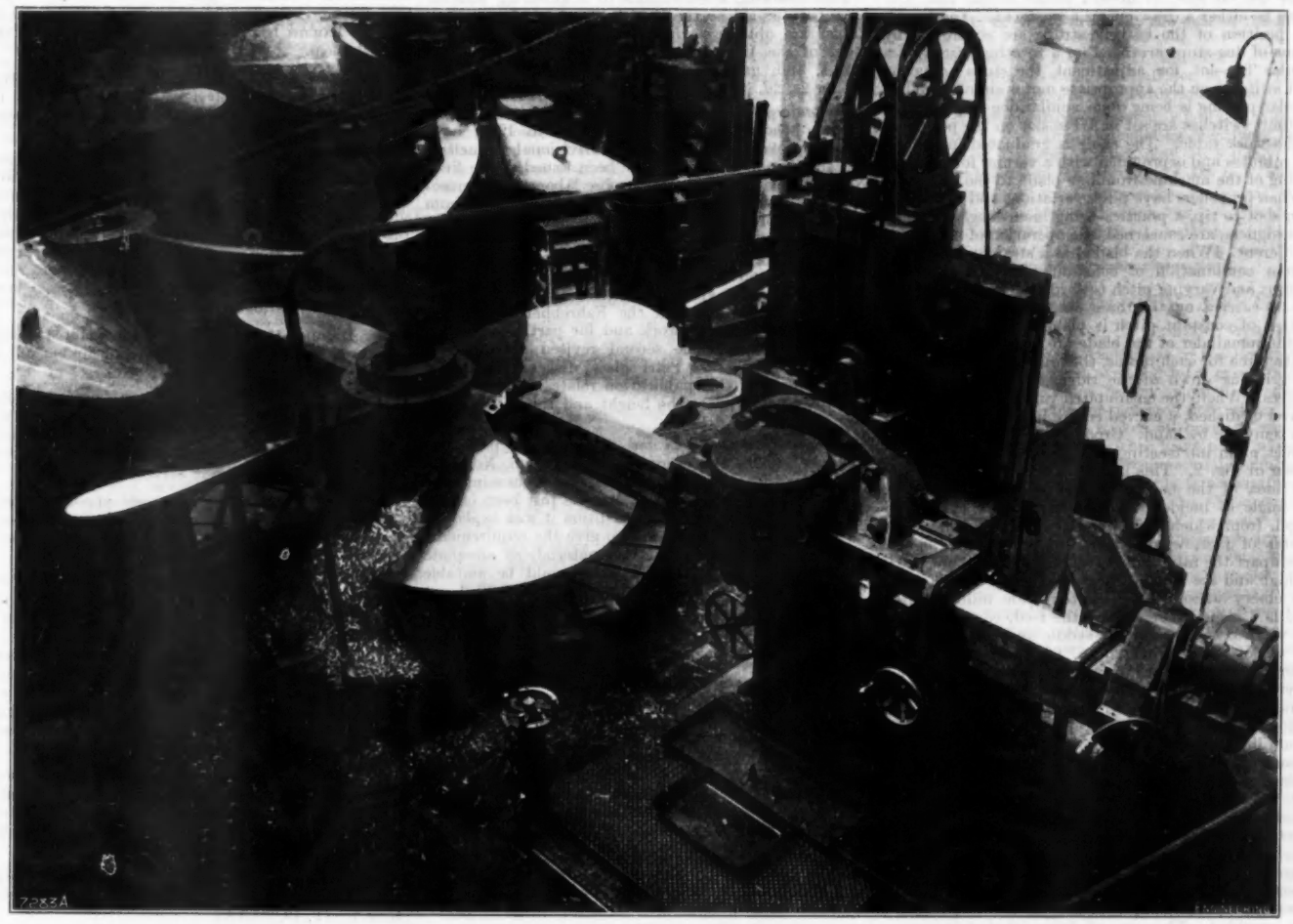


FIG. 1. MACHINE WORKING AS RADIAL PLANER.

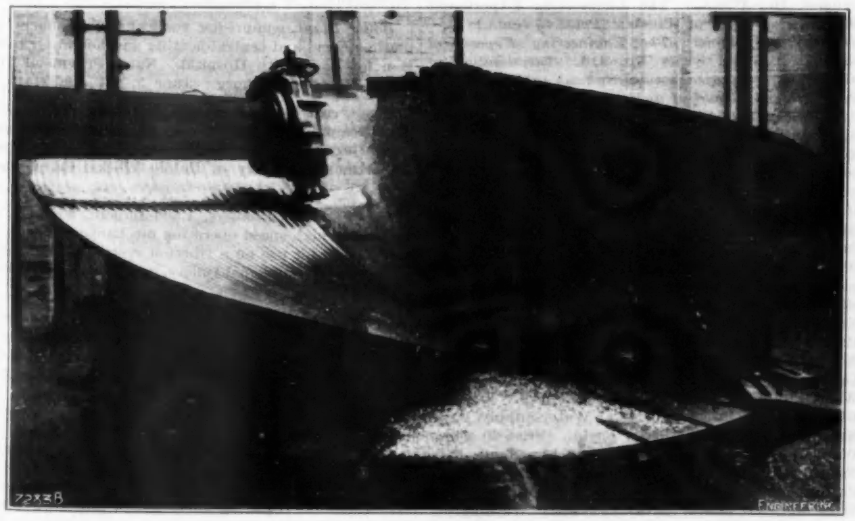


FIG. 2. MACHINE ENGAGED IN CIRCULAR MILLING.

Company, Muskegon Heights, Michigan, U.S.A. The new machine can deal with propellers up to 20 ft. in diameter by 20 ft. pitch, and having a blade-root diameter of 4 ft. The blades can have either a true helical, or screw-thread, surface with a constant pitch, or can have a variable pitch, a curvature from root to tip, or a backward rake, *i.e.*, with the radii of the blades not at right angles to the shaft axis. These requirements postulate different machining methods, and the machine, in consequence, is designed for radial planing, in which the cut is made along the length of the blades, or circular planing or milling, in which case the cuts are concentric with the propeller shaft. In addition, it can be used for drilling.

The general features of the machine are shown in Fig. 1, above, though the driving motors are masked by its column, and the bed between the column and the work table is hidden beneath the floor-boards. The column carries a saddle with vertical traverse, in which is mounted a rectangular ram supporting a cutting tool at one end. The work table is rotated at a speed in definite relation to the rate of traverse of the saddle, power for both motions being derived from the same source and variation of the relation, to suit different conditions of pitch, etc., being secured by change wheels. The ram has a reciprocating movement when a radial planing cutter is used and can be set at an angle in the vertical plane when raked blades are being dealt with. The reciprocating movement of the ram, which is of forged steel, is effected by the integral rack seen on its left-hand front face. The rack drive is distinguishable by its circular casings visible at the saddle centre. The drive is obtained from a reversing motor, not visible, the motor which can be seen at the extreme right of the illustration on the end of the ram being for the purpose of driving a forged-steel spindle which runs in the ram on roller bearings, with provision for thrust, and has a tapered nose to receive either face-milling cutters or drills; or, alternatively, receives the driving spindle of a right-angle milling head. This head is mounted on the ram, as shown in Fig. 2, and can be set with its tool spindle at any angle. The motor referred to drives the ram spindle through reduction gears and is of the variable-speed type.

The main motor is rated at 10 h.p. at 500 r.p.m., and is of planer-type design with a small armature to facilitate rapid reversal. When radial planing is being done, this motor only reciprocates the ram and the work table is rotated, to give the cutting feed and to traverse the saddle, by a second 10-h.p. motor with a variable voltage control giving a speed range from 12 r.p.m. to 1,200 r.p.m. When circular planing is being done the ram is not reciprocated, though it is traversed longitudinally to give the cutting feed, and the work table is rotated by the main motor, the cut being thus taken against a "fixed" tool in somewhat the same manner as a facing operation in a lathe. The operation of machining a constant-pitch truly helical propeller blade is shown in progress in Fig. 1. Obviously, if the blade is rotated at a rate which bears a definite relation to that of the vertical saddle traverse, the relation depending, of course, on the pitch, a true helical line will be generated by the point of a fixed tool. The reciprocation of the tool while the table is stationary would describe a radial line on the surface of the helix. By turning the work table through an angle representing the cutting feed during each return stroke

of the ram, successive cuts finally develop a helical surface, which is, in fact, the working surface of a constant-pitch propeller. The cut can be taken on either the outward or inward stroke of the ram, *i.e.*, it can be either a draw-cut or a push-cut. The length and position of the cutting stroke are controlled by means of dog-stops arranged on a rotating disc with a circular Tee-slot, for adjustment, the stops actuating limit switches on the appropriate motor circuit. When circular planing is being done, similar dog-stops operating limit switches are set in a Tee-slot on the periphery of the work table. The table is graduated in degrees and minutes and is provided with a vernier for accurate setting of the machine from one blade to the next.

When propellers have pitch variations and are curved from root to tip, a practice being increasingly followed by designers, are concerned, the operation of machining is different. When the blade has a straight centre line with a combination of constant pitch at the outer sections and varying pitch towards the root, the operation is carried out in three stages. First, the outer portion of constant pitch is planed, then datum lines for the remainder of the blade are milled at the appropriate pitch for each radius, the final stage consisting of the grinding down of the ridges between the milled grooves. Where the entire pitch varies and the blade is curved or dished, a curved centre line is cut accurately to a template by hand. Grooves are then milled to the correct pitch intersecting this prepared datum line, as shown in Fig. 2. This illustration may give an incorrect idea of the nature of the milling cut owing to the angle of incidence of the light when the photograph, from which it is reproduced, was taken. As a matter of fact, when the milled grooves are spaced 1 in. apart the intervening ridges are only about 0·010 in. high and are thus easily ground away by a portable cup emery wheel. The inserted-blade milling cutter used is 8 in. in diameter and the feed, compounded of the vertical traverse of the saddle and the rotation of the table, varies from 20 in. to 30 in. per minute, according to the depth of cut. Circular planing is less effective than milling for stock removal, but it is found in practice that, with propellers having a continuous rapid pitch change, it is better to cut the datum lines by circular planing in order to avoid interference of successive lines from the use of a large milling cutter.

A wide range of cutting and return speeds is provided by the main motor, which is of the Westinghouse-Electric improved variable-voltage planer type, with appropriate control. The cutting speeds of the ram range from 14 ft. to 100 ft. per minute in either direction of cut. An inching movement of 1½ ft. per minute for putting the ram into its initial position is also provided. The type of drive adopted is particularly advantageous for short strokes, since it is possible to get as many as 40 6-in. strokes per minute. For both incremental and continuous feeding, the latter for circular cutting, the work table is actuated by one or other of the two variable-voltage motors mentioned earlier. Incremental feeds are controlled by a relay, measuring actual motor revolutions, which stops and starts the feed motor, through electrical connections, at each reciprocation of the ram. The minimum incremental feed provided is equivalent to $\frac{1}{64}$ in. on 15 ft. diameter, the corresponding maximum being approximately $\frac{1}{16}$ in. Continuous feeding rates, such as would be used in milling, cover a range of from 2 in. to 12 in. per minute at 3-ft. diameter. For setting-up purposes, the table has a fast traverse speed of 60 ft. per minute, and a slow speed of 0·6 ft. per minute for spotting. Circular planing speeds range from 15 ft. to 45 ft. per minute for cutting and from 45 ft. to 60 ft. per minute for the return movement. All these rates are for 15 ft. diameter. The machine is equipped with about 100 change gears, so that it can develop any required pitch, at intervals of ¼ in., over the range from 6 ft. pitch to 20 ft. pitch.

The rheostats and contactor equipment for controlling the various motions are housed in a steel cubicle. Two rheostats are provided for controlling the ram movement in either direction, a third for the motor driving the ram spindle, another to control the continuous feeding rate of the feed motor, while two additional rheostats control the driving motor used for oscillating the table in circular planing. The stop and start push-button control pendant is seen at the operator's position in Fig. 1. The machine has been provided with equipment for milling the backs of propeller blades to small steel templates, which can be cheaply and accurately produced. This gear has not yet been installed, however, as the demand on the machine for the machining of working faces is too great to permit any use of it. Pending practical experience with it, therefore, no useful purpose would be served by a detailed description.

SAMPLE FAIR, BELGRADE.—It is proposed to hold the autumn International Sample Fair at Belgrade from September 7 to 16.

BRITISH STANDARD SPECIFICATIONS.

THE following specifications of engineering interest have been issued by the British Standards Institution. Copies are obtainable from the Publications Department of the Institution, 28, Victoria-street, London, S.W.1, and, unless otherwise stated, the price is 2*s.* net, or 2*s.* 2*d.* including postage.

Laboratory Thermometers and Petri Dishes.—Revisions of two specifications, first published in 1935, have been approved by the Chemical Divisional Council of the Institution and have now been issued. The first, No. 593, relates to general-purpose laboratory thermometers. Five series of thermometers, lettered from A to E, are provided for, the chief change in the revision being the inclusion of the last series (E), which has been specially chosen to be suitable for use in connection with distillation flasks specified in specification No. 571. The other series specified include thermometers, in both the Centigrade and the Fahrenheit scales, for more or less accurate work and for partial and complete immersion. The second revised specification, No. 611, relates to Petri glass dishes. The chief amendments in this publication relate to revisions of the tolerances and of the height and thickness of the top and bottom dishes.

Asbestos-Cement Slates and Sheets.—First published in July, 1936, a revision of specification No. 690, dealing with asbestos-cement slates and unreinforced flat sheets and corrugated sheets, has just been issued. In the preface to the original edition it was explained that it had not been possible to give the requirements relating to the quality of the material, as adequate information regarding what tests would be suitable was not then available. Research work, carried out with a view to evolving suitable performance tests, has now, however, been completed and the purpose of the revision is to include the new tests. These comprise a test for water absorption and a test for acid solubility, both of which have been found to be appropriate for testing the quality of the material. Limits for the results to be obtained with these tests are specified and a description of the methods by which the tests are carried out is also given. The opportunity has been taken to increase the figure specified for the transverse breaking strength of the corrugated sheets, and some editorial amendments have also been made.

BOOKS RECEIVED.

University of Illinois. The Engineering Experiment Station. Circular Series No. 40. *German-English Glossary for Civil Engineering.* By A. A. BRIELMAIER. Urbana, Ill., U.S.A.: The Engineering Experiment Station, University of Illinois. [Price 45 cents.]

University of Illinois. The Engineering Experiment Station. Bulletin Series No. 318. *Investigation of Oil-Fired Forced-Air Furnace Systems in the Research Residence. A Report of an Investigation Conducted in Co-Operation with the National Warm-Air Heating and Air Conditioning Association.* By PROFESSORS A. P. KRATZ and SEICHI KONZO. [Price 90 cents.] Bulletin Series No. 319. *Laminar Flow of Sludges in Pipes, with Special Reference to Sewage Sludge.* By PROFESSOR H. E. BABBITT and D. H. CALDWELL. [Price 70 cents.] Bulletin Series No. 320. *The Hardenability of Carburizing Steels.* By PROFESSOR W. H. BRUCKNER. [Price 70 cents.] Urbana, Ill., U.S.A.: The Engineering Experiment Station, University of Illinois.

United States Geological Survey. Water-Supply Paper No. 854. *Surface Water Supply of the United States,* 1938. Part 4. *St. Lawrence River Basin.* [Price 25 cents.] Water-Supply Paper No. 857. Part 7. *Lower Mississippi River Basin.* [Price 25 cents.] Water-Supply Paper No. 859. Part 9. *Colorado River Basin.* [Price 35 cents.] Water-Supply Paper No. 860. Part 10. *The Great Basin.* [Price 20 cents.] Water-Supply Paper No. 863. Part 13. *Snake River Basin.* [Price 30 cents.] Water-Supply Paper No. 864. Part 14. *Pacific Slope Basins in Oregon and Lower Columbia River Basin.* [Price 25 cents.] Washington: Superintendent of Documents.

Reports of the Progress of Applied Chemistry. Issued by the Society of Chemical Industry. Volume XXIV. 1939. London: Society of Chemical Industry, Clifton House, Euston-road, N.W.1.

Department of Scientific and Industrial Research. Index to the Literature of Food Investigation. Volume 11. No. 3. December, 1939. London: H.M. Stationery Office. [Price 4*s.* 6*d.* net.]

The Institution of Mechanical Engineers and the Institution of Production Engineers. Acceptance Test Charts for Machine Tools. Part I. London: The Institution of Mechanical Engineers, Storey's-gate, St. James's Park, S.W.1. London: The Institution of Production Engineers, 36, Portman-square, W.1. [Price 5*s.* 6*d.* net.]

PERSONAL.

MR. J. G. LOMAX, M.B.E., M.C., has been appointed Commercial Counsellor and MR. K. UNWIN, O.B.E., Commercial Secretary, to H.M. Embassy at Madrid. MR. W. HOUGH has been appointed Commercial Agent at Jerusalem.

PROFESSOR I. C. F. STATHAM, head of the Mining Department in the University of Sheffield, has been elected President of the Yorkshire Branch of the National Association of Colliery Managers.

MESSRS. WYNDHAM HEWITT, LIMITED, Lagonda Works, Staines, Middlesex, with which MESSRS. LAGONDA MOTORS, LIMITED, are associated, have formed a new subsidiary company, MESSRS. BRYCE FUEL INJECTION, LIMITED, which has acquired the whole of the assets of the fuel-injection equipment business lately carried on by MESSRS. BRYCE, LIMITED, Hackbridge, Surrey. The purchase includes all the special plant, stocks, goodwill, patents and designs.

DR. HAROLD HARTLEY has been appointed technical director of Messrs. Radiation, Limited, Thimble Mill-lane, Aston, Birmingham, 6.

MR. S. J. DAVIES, A.M.Inst.C.E., has been elected chairman of the Midland Counties Branch, MR. E. G. WARLAND chairman of the Lancashire and Cheshire Branch, and MR. J. WRIGHT chairman of the Scottish Branch of the Institution of Structural Engineers.

MR. GEORGE MORGAN has been appointed general manager of the Glasgow Electricity Department, in succession to MR. H. BELL. Mr. Morgan has been on the staff of the Department for 34 years.

TENDERS.

WE have received from the Department of Overseas Trade, Great George-street, London, S.W.1, particulars of the undermentioned tenders, the closing dates of which are as stated. Details may be obtained on application to the Department at the above address, quoting the reference numbers given.

Transformers, 4,500 kVA, 11 kV, three-phase, outdoor type, one for Hawera substation (T. 19,162/40), one for Oamaru substation and two for Invercargill substation. (T. 19,163/40.) Public Works Department, Wellington, N.Z.; July 9.

Steam-Cooking Apparatus for Ladysmith Hospital. Natal Provincial Tender Board, Pietermaritzburg; June 5. (T. 19,227/40.)

Switchgear, 50 kV, and steelwork incorporating a three-phase air-break switch. Public Works Department, Wellington, N.Z.; July 16. (T. 19,182/40.)

Boiler Plant, comprising vertical steam boilers, automatic stokers and central-heating and hot-water installation for Ladysmith Hospital. Natal Provincial Tender Board, Pietermaritzburg; June 5. (T. 19,221/40.)

Pipes, cast iron, of various diameters; also positive-type, reciprocating-piston, and rotary *Water Meters,* for Giza, Gezira and Helwan Tanzim Waterworks. Tanzim Department, Ministry of Public Works, Cairo, Egypt; June 15. (T. 19,322/40.)

Direct-Current Limiters, 1,500-ampere, 600-volt, complete with high-speed operating mechanisms and limiting resistances, for use on a traction system. Johannesburg City Council, Municipal Offices, Johannesburg; June 12. (T. 19,392/40.)

Cable End Boxes, extra high-tension, indoor-type, 150—0·2 by 3-core, and 160—0·06 by 3-core; and low-tension outdoor pole-type, 60—0·1 by 4-core. Johannesburg City Council, Municipal Offices, Johannesburg; June 15. (T. 19,400/40.)

SUPPLIES OF TIMBER FOR THE CONSTRUCTION AND MAINTENANCE OF MOTOR VEHICLES.—Manufacturers or coach builders requiring hardwood or imported softwood for the repair, maintenance or construction of motor vehicles, for civilian use in this country, or for export, should communicate with the Secretary, Ministry of Transport, Room 349, Metropole Buildings, Northumberland-avenue, London, W.C.2, to obtain the necessary forms of application. Applications for timber for vehicles for Service Departments should be made to the Service Departments requiring the vehicles, and, for vehicles for the Auxiliary Fire Services and Air-Raid Precautions Services, applications should be made to the Principal Priority Officer, Ministry of Health, Whitehall, S.W.1. For agricultural vehicles, applications should be addressed to the Ministry of Agriculture and Fisheries, Whitehall, S.W.1. Until further notice, applications for home-grown softwood or plywood should be made to an Area Timber Control Officer.

NOTES FROM THE SOUTH-WEST.

CARDIFF, Wednesday.

The Welsh Coal Trade.—The extension of the war to Holland and Belgium has had little effect on the Welsh steam-coal trade. Normally, these two countries draw the bulk of their supplies of British coals from producers on the North East Coast. Events of the past week or so, however, have resulted in some uncertainty being displayed on the market. On May 10, the Coal Export Officer issued a notice stating that export certificates for all destinations other than France, French and British possessions, were revoked. This notice, however, was cancelled on the following day, when a further announcement was made that the certificates which had been revoked would be re-issued immediately. Demand was sustained at an active level on the market, both home and overseas customers still displaying a very keen interest. The amount of business that could be arranged, however, was again severely curtailed owing to the difficulties confronting operators in covering their requirements. Collieries were still kept almost fully engaged in fulfilling orders already on their books, which, as a rule, were sufficiently well filled to ensure the steady absorption of potential outputs for a considerable time to come. The general tone was consequently very firmly upheld. The strongest feature of the market was still presented by duff coals. The potential outputs of these were earmarked for several months ahead, and, the demand being sustained, sellers were easily able to dispose of the occasional parcels that became available. Sized and large qualities were well provided with outlets and there were few offers of the small classes. Cokes were in sustained request, but with outputs well sold, little new business could be accepted, and the tone was firm. Patent fuel remained active.

The Iron and Steel Trade.—Very active conditions continued to rule in the iron and steel and allied trades of South Wales and Monmouthshire during the past week. The demand for the various finished products was briskly maintained, and works were engaged almost to full capacity in fulfilling orders already on their books.

NOTES FROM SOUTH YORKSHIRE.

SHEFFIELD, Wednesday.

Iron and Steel.—In conformity with the Government's request, industries in this area did not shut down for the holidays. Inland trade is brisk, while the overseas position is regarded as favourable. Sheffield Chamber of Commerce continues to receive inquiries from abroad for a variety of products. These include:—From Bulgaria, for tools; from Turkey, for wood and metal-working tools; from Australia, for axes, hatchets, carpenters' braces, pulley blocks, blacksmiths' anvils, horse-shoe nails, food mincers, and corn-mill plant; from Montevideo, for tools; and from South Africa, for farm and garden tools. The demand for basic-steel billets is exceptionally heavy, producers having difficulty in keeping pace with orders. The call for acid-steel is increasing. There is an active market for strip of all kinds, and structural steel is a progressive medium. Rolling mills, forges, press shops, and wire and rod departments are exceptionally busy, and makers of steelworks and ironworks machinery and related equipment are also fully employed. The orders in hand include electric furnaces, gas-fired furnaces, rolling mills, forges, presses, bending machines, etc. Sheffield's trade in shipyard equipment, steel, forgings and castings is reaching record dimensions. The seasonal buying of agricultural machinery and parts has also developed to its fullest extent; the inland demand has been high, orders being so numerous that producers will have to work at high pressure for months ahead. In addition, the demand from the Colonies and Dominions is substantially greater than in normal times. Makers of all types of high-efficiency steels report an increasing demand, among the steels called for being stainless, heat- and acid-resisting, and material capable of withstanding excessive wear. The tool-making trades are also operating at high pressure.

South Yorkshire Coal Trade.—The demand for most classes of coal are active. South Yorkshire pits are supplying large tonnages of industrial coal, and locomotive coal is also in demand. The house coal markct is satisfactory for the time of the year; supplies to the South of England and London have been maintained. The coke market is very satisfactory, and sales are above pre-war levels.

BRASSFOUNDERS' EXPORT GROUP.—Mr. F. V. Madeley has been appointed chairman and Mr. F. J. Collis, secretary, of the newly-formed Brassfounders' Export Group. The offices are at 106, Edmund-street, Birmingham, 2.

NOTES FROM CLEVELAND AND THE NORTHERN COUNTIES.

MIDDLESBROUGH, Wednesday.

General Situation.—Few new features are noticeable in the iron and allied trades. The production of nearly all commodities is maintained at an exceptionally high level, but pressure for supplies continues and makers of several descriptions of material are still in arrears with deliveries. Contracts unfulfilled at the end of next month will be automatically cancelled and new allocations, under the control of distribution system, are expected to be made. Foundry iron is in only moderate request, the requirements of consuming works being rather below the normal, although the demand is increasing. The supply is ample, coming mainly from Midland districts. Tees-side products are also employed for foundry work and are quoted on the basis of No. 3 Cleveland pig at 111*s.*, delivered within the Tees-side zone.

Hematite.—The heavy and expanding demand for East Coast hematite is taxing the sources of supply. The large output is passing promptly into use and may have to be increased shortly, as producers have little tonnage stored and most of the iron on hand is earmarked for early distribution. Producers' own consuming departments continue to absorb the bulk of the supply. Buyers however, are calling for larger deliveries under running contracts and are anxious to place substantial new orders. The stabilised prices are ruled by No. 1 grade of hematite at 127*s.* 6*d.*, delivered to North of England areas.

Basic Iron.—There is still no saleable tonnage of basic iron, and with the whole of the production needed for use at the makers' adjoining steelworks, the quotation of 104*s.* 6*d.* continues to be nominal.

Foreign Ore.—A steady import of foreign ore is reported and consumers have good stocks.

Blast-Furnace Coke.—Business in Durham blast-furnace coke is quiet, local users being extensively covered and holders having sold as much as they care to commit themselves to. The recognised market values are at the equivalent of good medium qualities at 31*s.* 8*d.* at the ovens.

Manufactured Iron and Steel.—Semi-finished iron and steel deliveries are sufficient for the heavy requirements of re-rollers. Finished-iron manufacturers are booking larger orders than formerly, and finished-steel producers have more work on hand than they can carry out within the time stipulated for the completion of running contracts. The deliveries of shipbuilding requisites continue on an exceptionally large scale.

Scrap.—The improvement in the deliveries of iron and steel scrap is maintained, but all the available tonnage is promptly taken up by consumers.

STAINLESS-STEEL MANUFACTURERS' EXPORT GROUP.—The Chairman of the newly-formed Stainless-Steel Manufacturers' Export Group is Mr. C. E. Holmstrom, director of Messrs. Firth-Vickers Stainless Steels, Limited, and the Secretary, Mr. E. J. Gadsby, who is also Secretary of the Sheffield Stainless-Steel Manufacturers' Association, 44, Bank-street, Sheffield, 1. Firms interested in the exportation of stainless steels are requested to communicate with Mr. Gadsby at Wharncliffe House, Bank-street, Sheffield, 1.

THE INSTITUTION OF MINING AND METALLURGY.—The Gold Medal of the Institution of Mining and Metallurgy, the highest distinction in its power to bestow, has been awarded to Dr. S. G. Blaylock in recognition of his outstanding achievements in advancing the science of metallurgy in the Dominion of Canada. The Consolidated Goldfields of South Africa, Limited, Premium of 40 guineas has been awarded to Dr. A. C. Skerl, for his paper, "The Geology of the I.X.L. Gold Mine, Masbate Island, Philippines." The William Frecheville Students' Prize of 10 guineas has been awarded to Mr. G. A. Schnellmann, and the Arthur Claudet Students' Prize of 10 guineas to Mr. Ralph Daniel.

SCRAP IRON AND STEEL PRICES.—The Minister of Supply has made an addition, entitled Direction (No. 3), to the Control or Iron and Steel (No. 7) (Scrap) Order, 1940. This increases the maximum prices for scrap iron and steel, as from May 6, 1940, to meet the recent increase in railway charges. In the case of scrap iron and steel for the manufacture of steel ingots, otherwise than in electric-arc furnaces, the maximum prices have been increased by 1*s.* 6*d.* per ton for consumers in South Wales (West); by 1*s.* per ton for consumers on the North West Coast and in Cheshire (including Shotton), Brymbo and South Wales (East); by 6*d.* per ton for consumers in the Midlands (except for two grades of cast iron, which are increased by 1*s.* per ton); and by 9*d.* per ton for consumers in all other districts. All other grades of scrap are also increased by 9*d.* per ton. The price of scrap c.i.f. ports or wharves remains unaltered.

NOTICES OF MEETINGS.

IT is requested that particulars for insertion in this column shall reach the Editor not later than Tuesday morning in the week preceding the date of the meeting.

INSTITUTION OF MECHANICAL ENGINEERS.—To-night, 6.30 p.m., Storey's-gate, Westminster, S.W.1. Informal Meeting. Exhibition of Cinematograph Films.

ROYAL INSTITUTION.—To-night, 9 p.m., 21, Albemarle-street, W.1. "A Great Calculating Machine," by Professor D. R. Hartree. Friday, May 24, 9 p.m., "Ultra-Violet and Electron Microscopy," by Dr. L. C. Martin.

INSTITUTE OF FUEL.—Thursday, May 23, 6 p.m., King's College, Newcastle-upon-Tyne. "Coals 'Dangerous to Oven Walls," by Dr. R. A. Mott.

NOTES FROM THE NORTH.

GLASGOW, Wednesday.

Scottish Steel Trade.—Conditions in the Scottish steel trade have not changed over the week except that the demand for supplies has become more imperative and consumers are pressing for increased deliveries. Production, which has already broken all previous records, is being maintained and efforts are being made to increase it still further. All kinds of steel material are in request, and the speed-up in the shipyards is accounting for a heavy demand for plates, etc. The black steel-sheet makers are producing to their full capacity and are receiving urgent demands from makers of drums and containers of all descriptions. Constructional engineers are pressing for deliveries of sectional material. Prices are firm and are as follows:—Boiler plates, 13*l.* 8*s.* per ton; ship plates, 12*l.* 10*s.* 6*d.* per ton; sections, 12*l.* 8*s.* per ton; medium plates, under $\frac{3}{16}$ in. thick, weighing 6 lb. or more per square foot, 14*l.* per ton, and weighing less than 6 lb. but not less than 4·81 lb. per square foot, 14*l.* 10*s.* per ton; black steel sheets, No. 24 gauge, in 4-ton lots, 17*l.* 10*s.* per ton; and galvanised corrugated sheets, No. 24 gauge, in 4-ton lots, 20*l.* per ton, all delivered at Glasgow stations.

Malleable-Iron Trade.—In the West of Scotland malleable-iron trade conditions are satisfactory. The re-rollers of steel bars are fully occupied at present, and although stocks of semi-manufactured material are ample for immediate requirements, forward supplies must be maintained to ensure continuity of production. Shipments have been coming in from different sources to augment local supplies, and consumers are hopeful that these will continue. The following are the current quotations:—Crown bars, 14*l.* 2*s.* 6*d.* per ton; No. 3 bars, 12*l.* 10*s.* per ton; No. 4 bars, 12*l.* 15*s.* per ton; and re-rolled steel bars (tested), in 4-ton lots, 14*l.* 3*s.* per ton, all for home delivery.

Scottish Pig-Iron Trade.—There has been no change in the state of the Scottish pig-iron trade during the past week, and the output from all furnaces is at a maximum. Ample stocks of iron ore are on hand, and satisfactory arrangements have been made to keep up supplies. Makers are having to face a steady demand from consumers of hematite and basic iron, and the sale of foundry grades is also increasing. To-day's market prices are as follows:—Hematite, 6*l.* 7*s.* 6*d.* per ton, and basic iron, 5*l.* 4*s.* 6*d.* per ton, both delivered at the steel works; foundry iron, No. 1, 5*l.* 15*s.* per ton, and No. 3, 5*l.* 12*s.* 6*d.* per ton, both on trucks at makers' yards.

BORDEAUX FAIR.—The 24th Bordeaux Fair is to be held from June 16 to July 1. The offices of the Fair are at Palais de la Bourse, Bordeaux.

TROLLEY OMNIBUSES FOR ROTHERHAM CORPORATION.—Messrs. Sunbeam Commercial Vehicles, Limited, Moorfield Works, Wolverhampton, inform us that an order was placed last year by the Rotherham Corporation for a fleet of Sunbeam-B.T.H. trolley-omnibus chassis, and that this has now been followed by an order for a further eight chassis of the same type, which are of six-wheel design. A number of important other contracts for trolley omnibuses, both for home and overseas, are also in hand.

SMALL PORTABLE ELECTRIC LIGHTING UNIT.—The "Ensur-a-Lite Junior" lighting unit, which has recently been placed on the market by the Edison Swan Electric Company, Limited, 155, Charing Cross-road, London, W.C.2, is designed to give compactness with as large an illumination as possible. It consists of a 2-volt accumulator with a switch and lamp attachment, the former consisting of Bakelite and the latter being of the screw-in type. The container is of moulded glass and is sealed so that the electrolyte cannot be spilled. The bulb is hooded to ensure concentration of light in the downward direction and the guaranteed life on one charge is from 50 to 60 hours.

18-FT. DOUBLE-HEADED UNIVERSAL GEAR-HOBBING MACHINE.

MESSRS. THE POWER PLANT COMPANY, LIMITED, WEST DRAYTON.

(*For Description, see Page* 498.)

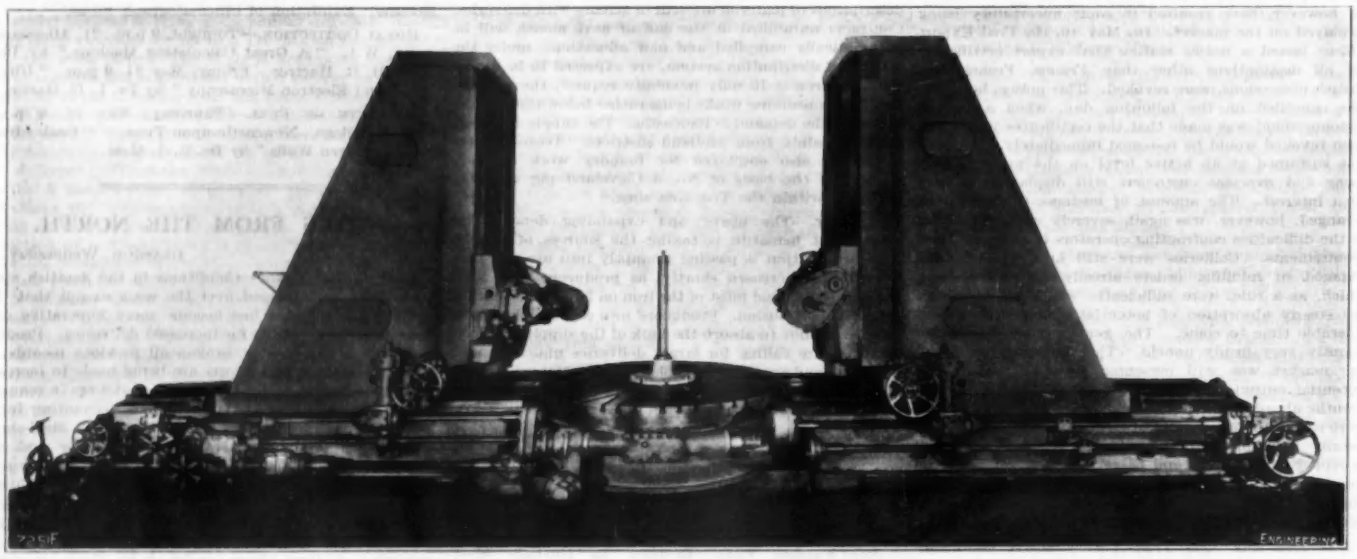


Fig. 12. Operating Side of Machine.

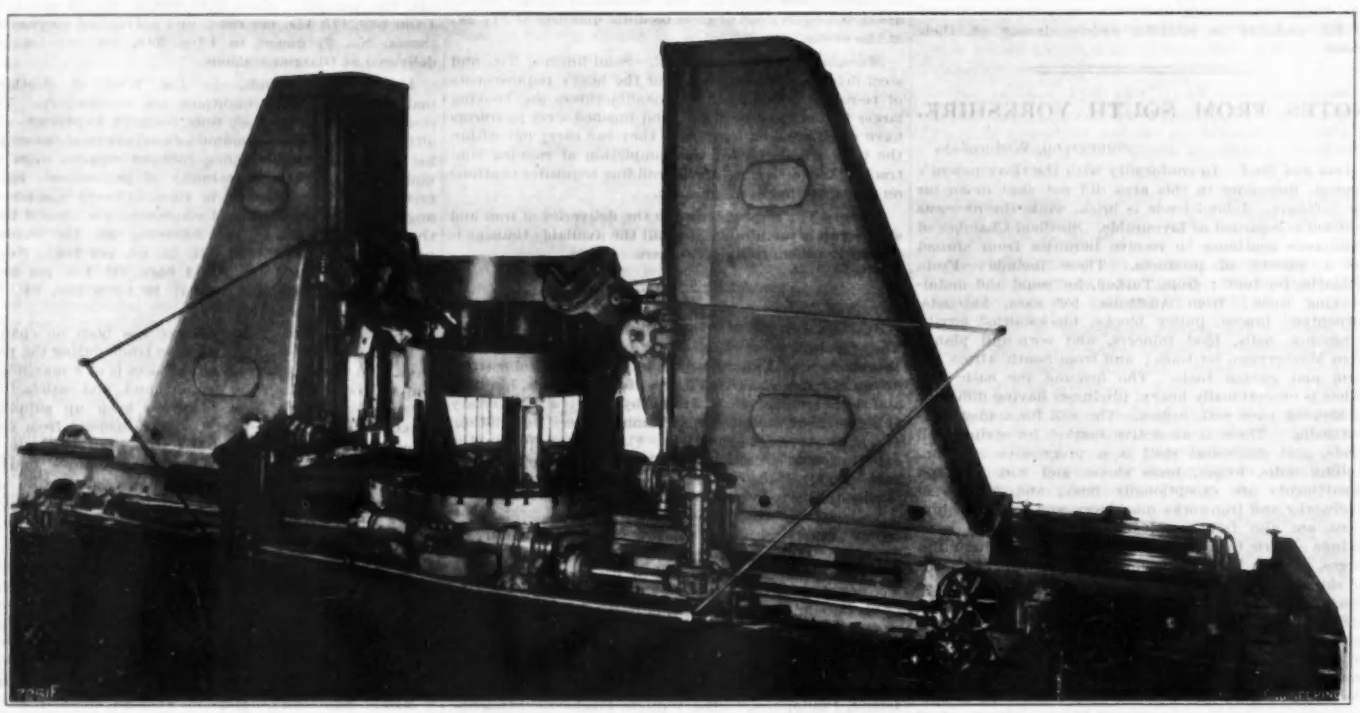


Fig. 13. Hob-Driving Side of Machine.

THE ASBESTOS MINING INDUSTRY.

According to statistics published by the United States Bureau of Mines, Canada is the chief source of world supplies of asbestos, the Dominion's production totalling 330,642 metric tons in 1939, compared with 262,885 tons in 1938, 371,967 tons in 1937, and 273,322 tons in 1936. Second in importance as a producing country is Soviet Russia, and although the output figure for 1939 is not available, that for 1938 was 86,000 tons, compared with 125,000 tons in each of the two preceding years. The third largest producing country is Southern Rhodesia, which accounted for an output of 53,352 tons in 1938, compared with upwards of 51,000 tons in each of the two previous years. In the case of Southern Rhodesia, and in that of several other countries statistics of which are given below, figures for the 1939 production are not yet available. Other British Empire territories in which asbestos mining is carried on are the Union of South Africa, which produced upwards of 20,000 tons in each of the four years 1935-1938, and Cyprus, which exported 5,668 tons in 1938, against 11,892 tons in 1937 and 9,659 tons in 1936. The only European country in which mining for asbestos is conducted appears to be Italy, the Italian production for 1938 being 6,860 tons, compared with 6,393 tons in 1937 and 6,113 tons in 1936. In the United States, which constitutes the largest asbestos-consuming country in the world, only a fraction of the annual requirements is produced at home. Thus, while the apparent consumption of the mineral totalled 256,072 short tons in 1939, only 15,984 tons were produced within the United States. Exports comprised a mere 2,473 short tons, and, of the 242,561 tons imported, 223,840 tons came from Canada, 6,359 tons from the South African Union, 4,836 tons from other British territories in Africa, 3,940 tons from Cyprus and other British Mediterranean islands, and 2,611 tons from the Soviet Union.

"Hurricane" Fighter at the Science Museum.—A Hawker "Hurricane" fighter aircraft which has seen active service with the Fighter Command in the defence of the United Kingdom has been placed on exhibition at the Science Museum, South Kensington, London, S.W.7. This machine, which has been lent by the Air Ministry, has been included in the special exhibition of "Aircraft in Peace and War," which was opened during February and has already been visited by some 55,000 people. The Science Museum is open free to the public on weekdays, including Bank Holidays, from 10 a.m. to 6 p.m., and on Sundays from 2.30 to 6 p.m.

18-FT. DOUBLE-HEADED UNIVERSA

CONSTRUCTED BY MESSRS. THE POWER PLANT COMPA

(For Description see P

Fig.1.

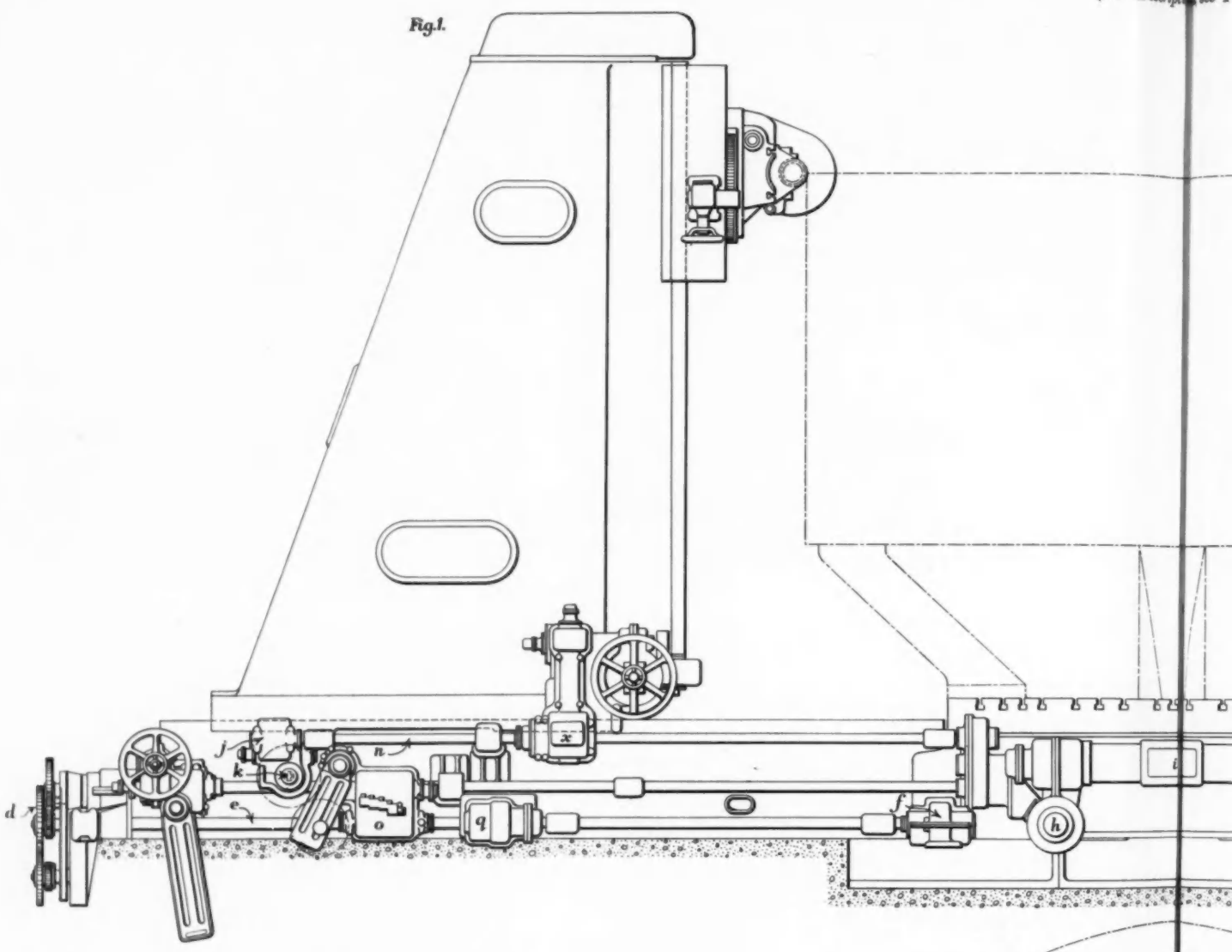
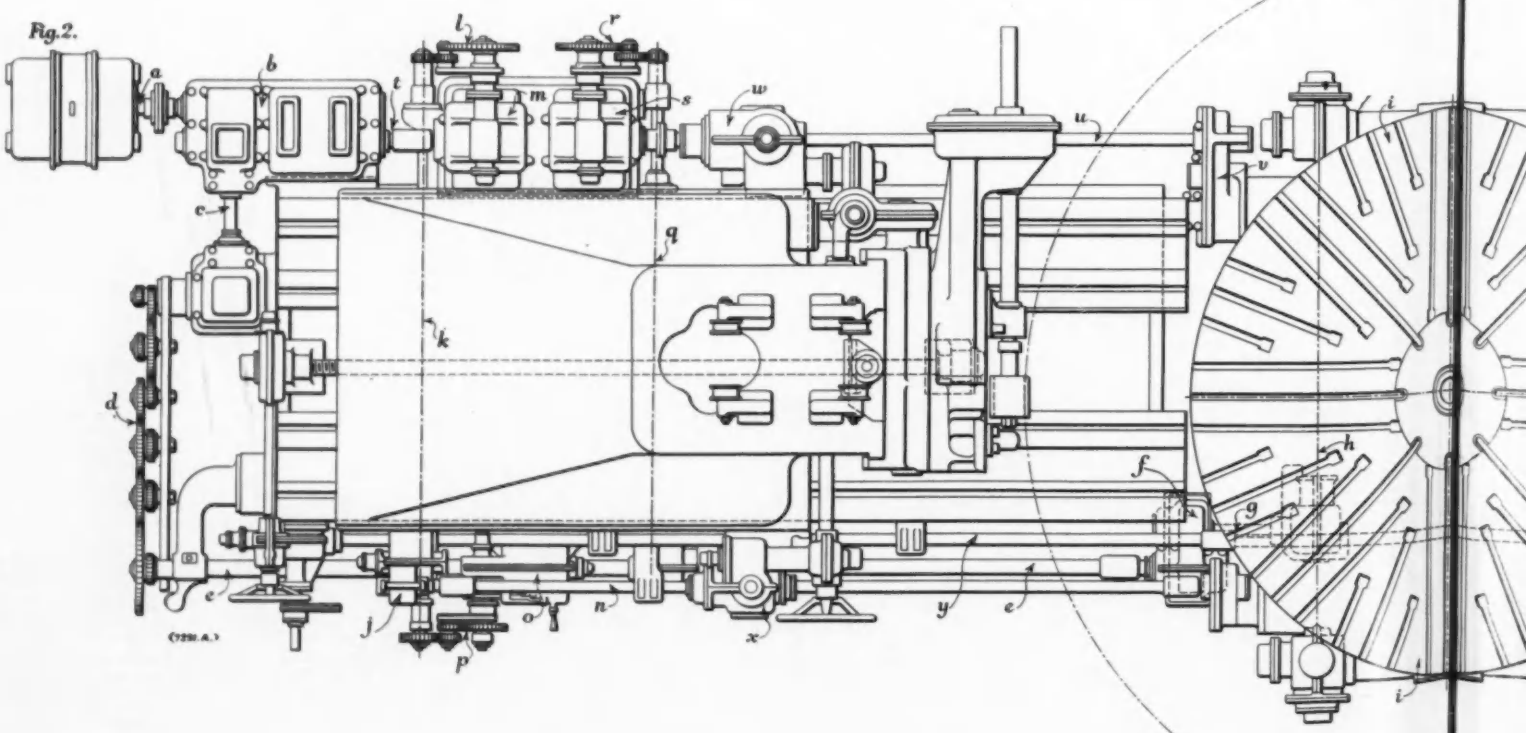


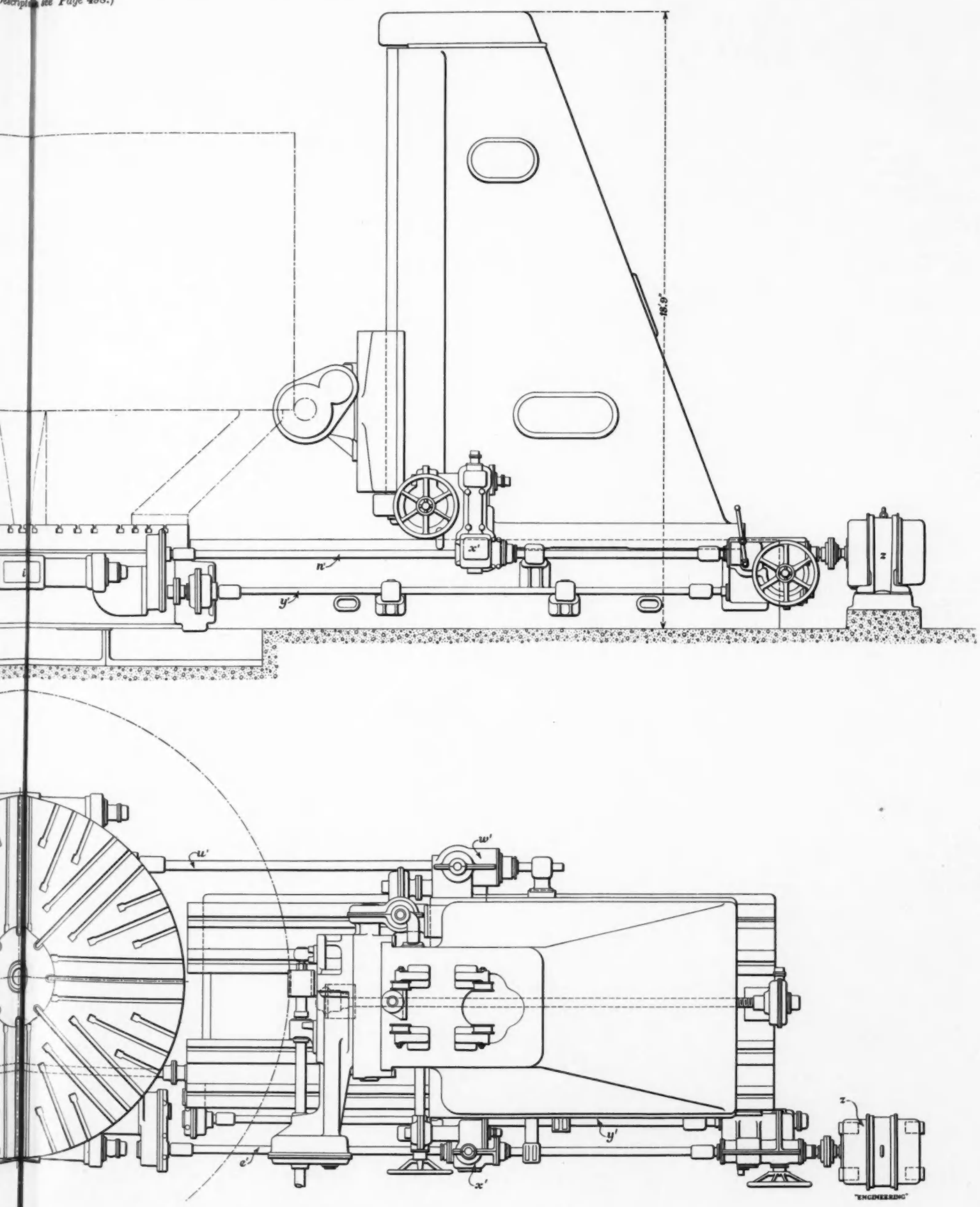
Fig.2.



IVERSAL GEAR-HOBBING MACHINE.

PLANT COMPANY, LIMITED, ENGINEERS, WEST DRAYTON.

(Description see *Page* 498.)



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CONTENTS.

	PAGE
The Chilcote Pumping Station and Softening Plant of the South Staffordshire Waterworks Company (*Illus.*)	495
The Markets of Latin America	497
18-Ft. Double-Headed Universal Gear-Hobbing Machine (*Illus.*)	498
Planing Machine for Marine Propellers (*Illus.*)	500
British Standard Specifications	502
Books Received	502
Personal	502
Tenders	502
Notes from the South-West	503
Notes from South Yorkshire	503
Notes from Cleveland and the Northern Counties	503
Notices of Meetings	503
Notes from the North	503
The Asbestos Mining Industry	504
The Health of Munition Workers	505
Air Conditioning in Ships	506
Notes	507
Recent Court Cases—VI	507
The Iron and Steel Institute	508
Letter to the Editor.—The Kadenacy System of Scavenging	509
The Port of New York	509
Gas-Engine Contact Maker for Tropical Service (*Illus.*)	510
The Late Mr. W. B. Esson	511
The Late Mr. H. J. Ward	511
Labour Notes	511
Problems of the Singing Propeller (*Illus.*)	512
3-Cub. Yd. "Walking" Dragline Excavator (*Illus.*)	513
Catalogues	513
Reinforced-Concrete Pit Props	514
"ENGINEERING" Patent Record (*Illus.*)	514

One Two-Page Plate.—18-FT. DOUBLE-HEADED UNIVERSAL GEAR-HOBBING MACHINE.

ENGINEERING

FRIDAY, MAY 17, 1940.

VOL. 149. No. 3879.

THE HEALTH OF MUNITION WORKERS.

AT the present time, the term "munition workers" may be held to cover a large proportion of the factory workers of the country. Although many of these may not be directly employed on armaments, the work they are doing will, in the majority of cases, have close connection with the prosecution of the war. Indeed, if we are to accept what we are told about the economic front, then all workers are munition workers. The fashionable way of expressing this fact at the moment is to refer to the war as a "total" war. Certainly, it will be total before it is finished, but for the moment it is difficult to believe that it is as total as was the war of 1914-1918. Recent governmental changes raise hopes that the attainment of totality in the industrial side of our war effort may be hastened. Mr. Churchill has said that our peril is greater than at any time during the four-years' war, and yet the nation still hesitates to put forward the industrial effort which was displayed at that time. We have more than once referred to the indispensability of employing an enormously greater proportion of women in industry. In the war of 1914-1918, 25 per cent. of the switchboard attendants in the smaller sub-stations of the Glasgow Corporation Electricity Department were women. This is a small matter, but it illustrates the conditions which ruled at that time and enforces the lesson that the present period is not one in which time should be wasted in arguments and disputes about trade-union or other rules and regulations.

There is no question about the ultimate attainment of this greater industrial effort. The only point at issue is how soon we are to reach it. It is to be hoped that the experiences of the previous war, which are still in the memories of many of those who are responsible for the carrying on of industry, will be turned to useful account. Sir Nevile Henderson, in his recent book, *Failure of a Mission*, points out that Germany has initiated, or been principally responsible for, five wars in the last seventy years. The present outbreak has, at least, the qualification of coming so closely after the previous war that the events of that time are sufficiently recent to enable us to take advantage of what we then learned. Had a period of 44 years elapsed between the two conflicts, as was the case between the Franco-German war of 1870 and the outbreak of 1914, we might have had time to forget our lessons. It is presumably with the idea of ensuring that the new industrial effort shall be carried on with maximum efficiency, and that what we learned in 1914-1918, and have learned since, shall be taken full advantage of, that the Industrial Health Research Board, of the Medical Research Council, has published a recent pamphlet, *Industrial Health in War.** It is described as Emergency Report No. 1.

As in the earlier conflict, we have now to introduce very large numbers of new hands into our engineering factories, to build and equip new workshops and to speed-up production in every possible way. These activities were not carried out in the last war without loss both of time and energy in ill-directed and ill-considered proceedings. In a time of emergency, some makeshifts must be made to serve, but there is more reason than usual, not less, for making sure that energy shall not be dissipated in fruitless exertions. Quite apart from factory lay-out and equipment, it is possible to lose output by unsuitable accommodation for the workpeople or by the institution of excessively long hours over extended periods. It is with considerations of these latter types that the pamphlet is concerned. The Industrial Health Research Board, which was formerly known as the Industrial Fatigue Research Board, is the direct descendent of the Committee on the Health of Munition Workers, which was set up during the last war. This Committee operated in a time of stress when long-scale investigations were out of the question, but matters of the type to which it directed its attention have been studied by its successors over the intervening twenty-five years and many data have now been accumulated.

The Industrial Health Research Board, since its institution, has published a series of reports, the total number of which is now approaching a hundred. The first appeared in 1919. These reports are, in general, fairly well known to industrialists and many have been dealt with in our columns at the time of their appearance. There are, however, doubtless many who are concerned with the operation of engineering shops who have given them comparatively little attention. To these, the summary of the twenty-five years work of the Board, which the pamphlet provides, will prove of value and interest. The publication of a digest of this work in brief compass will also be a convenience to those more familiar with the activities concerned. Some of the sections of the pamphlet cover matters on which there is now little difference of opinion in industrial circles. The provision of adequate lighting and proper heating and ventilation are examples of these. About the first nothing need be said, but when, in view of the workshop temperatures recommended for different types of work, and the requirements concerning air changes, it is stated that the report is "a summary of research findings capable of immediate application in furtherance of the national effort," it must be pointed out that the standards suggested may be very difficult to attain immediately in many existing premises. All work is not being carried on in modern factories of the type of which many are to be seen in the London area, and the bringing of many old shops up to the standard of the modern best is certainly not a thing which can be carried out "immediately."

The recommendations concerning accident prevention, ambulance services and the keeping of health records are not likely to induce much difference of opinion, but the Board is not likely to find unanimous acceptance of its view regarding hours of work. The Board is aware of the fact that we are at war with Germany—that is what has led to the publication of its pamphlet—but it does not seem to realise that what is desirable in peace may be undesirable, or even impossible, in war. On the general broad proposition, that excessive hours worked over long periods may result in some

* H.M. Stationery Office. Price 6*d.* net., postage extra.

loss of efficiency, there is not likely to be any difference of opinion; but the principle that everyone must have his Sunday off may well result in the expression of a very different point of view. The output of many of the things we require most urgently depends on the number of hours the machine tools are run, and it is no less than a matter of life and death that the machines should not be left standing for the whole of one day a week. Workpeople cannot carry on with a seven-day week indefinitely, but there are factories in this country, engaged on vital output, in which a seven-day week is worked, with a week-end off each month. No doubt the workpeople concerned—who, incidentally, fully recognise the necessity for the procedure—may suffer from considerable fatigue, but they probably realise, as apparently the Industrial Health Research Board does not, that very many people will suffer much worse things than considerable fatigue in this war.

We do not know how much data is in the possession of the Board, supporting their contention that a reduction in hours increases output—presumably there is some limiting condition, but what it is, is not stated. Actually, they are content to illustrate this proposition by a single example. Fifty-six men were engaged "in the heavy labour of sizing fuse bodies." During three periods they worked, respectively, 66·7, 62·8 and 56·5 hours a week. The relative total outputs during these periods were 100, 106 and 122, and the relative hourly outputs 100, 122, and 139. These figures look impressive, but when it is stated that, although the nominal hours in the three periods were 66·7, 62·8, 56·5, the hours actually worked were 58·2, 50·5 and 51·2, the figures assume a different aspect. In the middle period of 62·8 hours, the time lost "for various reasons, such as waiting for work," was no less than 24 per cent. of the hours actually worked. With the 56·5-hour week, the corresponding loss was 8·4 per cent. Both of these figures are much too high and suggest that this example has been collected from an inefficient organisation. No actual output figures are given, but if the ridiculous figure of 24 per cent. is brought nearer to the 8·4 per cent. figure, it is clear that the total output of the 62·8-hour week would come a good deal closer to that of the 56·5-hour week. Men standing about for 24 per cent. of the time they are actually working are likely to become disorganised and to fail to work at their best for any part of the day; it is impossible to draw any conclusions from such inefficient procedure. If the Industrial Health Research Board is convinced that reductions in hours increases output, as it appears to be, why does it not produce adequate evidence supporting its belief? To put forward a general proposition of that kind supported only by one weak example, in a time of stress like the present, when output must take precedent of everything, is nothing less than mischievous.

AIR CONDITIONING IN SHIPS.

AMONG the less obvious consequences of Abraham Lincoln's Gettysburg address may be reckoned the American attitude towards domestic service, which has led directly to the invention of a host of labour-saving devices, and to the relatively advanced state of domestic engineering in that country. The point is well exemplified by air conditioning, already, in the United States, passing rapidly from a luxury to a matter of course, but, in India, still a rarity, despite climatic conditions much less readily supported by the white population, and despite the fact that it was Lord Kelvin—then Professor Thomson—who, addressing the British Association nearly a hundred years ago, first proposed mechanical cooling as a means of improving human comfort. The fact is that the equable temperatures of the British Isles have not, so far, encouraged the manufacture of air-conditioning equipment for home use to the degree that a restricted foreign and colonial market can be profitably supplied. These considerations of national temperature and temperament refer especially to the air-conditioning of buildings, but they bear also upon railway trains where the Americans have had the additional incentives of long, transcontinental journeys and the dust-laden atmospheres of the middle west. Although its publicity value has undoubtedly weighed heavily with the railroads, it is significant of the intrinsic worth of air conditioning in American trains that seasoned travellers welcome it as a long-overdue necessity rather than as a luxury.

Some of the appreciation of air-conditioned trains follows from the restriction of movement and occupation imposed upon the passenger in a public vehicle. To a less extent, these factors apply also to the passenger accommodation in ships, but the conditions there approximate more closely, on the whole, to those of an hotel. For one thing, the passenger liner and holiday cruiser cater for a multi-national clientele, an increasing proportion of whom have experienced the comfort of conditioned air and consider themselves justified in expecting it, whether their hotel is on shore or afloat. What is of more importance to British engineers, however, is that this country has a world-wide reputation for building and operating fine ships, many of which encounter an extreme range of climatic conditions in the course of every voyage. Here the factors which temper the need for air conditioning in buildings and vehicles no longer apply.

It may be noted that the air-treating equipment in a ship must be carried wherever the ship may go, costing money for fuel and occupying space which otherwise might contain pay-load. Again, the rate at which a ship passes from one extreme of atmospheric temperature to another is much more rapid than the seasonal variations experienced on land, so that the plant must be capable of almost daily re-adjustment. For these reasons, to which must be added the impracticability of carrying out major replacements or structural alterations at sea, it is of greater importance than in land practice that marine air-conditioning equipment should be efficient, compact, and reliable. The second point—the versatility or comprehensiveness of the plant, and of the knowledge required to design and operate it—arises from the fact that the community on board ship is self-contained and self-supporting throughout each voyage. The public and private accommodation for passengers demands all the amenities of a great hotel and embraces an even greater variety of air treatment requisite for dining, smoking, and state rooms, kitchens and food stores, a cinema and a sick-bay; with which are associated corresponding ranges of physical activity, air pollution, and incidental heating. In a separate category, calling for air conditioning on industrial lines, are the engine room and stokehold, where the combination of heat, humidity, dust, boiler draught and hard-working men raises difficult problems. Many ships, in addition, contain refrigerated cargo space which demands at least the plant and knowledge of cold-storage practice.

Without further elaboration it is clear that the air conditioning of ships presents many new problems outside the range of experience encountered anywhere on shore, and offers greater scope for future development than can at present be foreseen. It is safe to assert that, in relation to the British shipbuilding industry, the subject is, as yet, neither well enough nor widely enough understood: considerations which enhance the value of the excellent paper on "Air Conditioning in Ships' Passenger and Cargo Spaces," which Mr. W. H. Glass read at Newcastle, on March 29, before the North-East Coast Institution of Engineers and Shipbuilders. In many respects, of course, the passenger ship and the hotel are similar enough for the same general rules to be followed, and the same physiological factors to be taken into account. In these respects, for want of data more specifically related to conditions encountered at sea, Mr. Glass deduced his figures for requirements and plant capacity from the results of research carried out by the American Society of Heating and Ventilating Engineers in co-operation with the Bureau of Mines and the United States Public Health Service. No doubt these are excellent data, based on statistical evidence and embodying the effects on human comfort of quantity, temperature, humidity and movement of the ventilating air supply, but it may be suggested that they do not represent finality in marine practice. It is not that the data are inadequate for the time being—the human body is accommodating enough to adapt itself to any likely deficiencies—but rather that, for some time to come, the range of air-conditioning plant installed in ships should be elastic enough to permit a certain amount of experimental variation, from the results of which information may gradually be accumulated regarding the optimum conditions for different classes of ship and voyage.

Among the points which Mr. Glass rightly emphasised are the heat contributions from electric lights, fan motors and sources external to the air-conditioning system; and the thermal properties of the boundaries of air-conditioned rooms. Many of these factors are appreciably different in a ship from those experienced in buildings. The heat from engines, boilers and uptakes, for instance, affects the lay-out and insulation of ventilating ducts, especially when the most useful function of the air-conditioning plant is to cool the ship in tropical weather. The thermal capacity of panelling and furniture exerts a marked influence upon the rate at which the plant can counteract changes of ambient temperature. These are important matters, inasmuch as the effectiveness of the installation depends on the accuracy with which they can be estimated before the ship's keel is laid down; they also suggest that the capacity of the system should be determined partly by the volume of the rooms to be conditioned, and not solely by the number of occupants. Mr. Glass, advocating the latter basis, very properly observed that the body heat of the occupants of a dining saloon has an important bearing on the desirable condition of the ventilating air supply. It can be argued, however, that the heat, humidity and odours introduced by food are only indirectly related to the number of occupants; that a dining saloon is fully occupied only for brief periods; and, consequently, that its preparation during the unoccupied intervals into a suitable condition for use is, perhaps, the more economical mode of utilising air-conditioning equipment.

Mr. Glass's appreciation of the practical details of his subject was well exemplified by his remarks on the merits of air movement in producing a sensation of freshness in an air-conditioned apartment, with which must be considered the form and disposition of input and outlet apertures to ensure uniform distribution and a thorough yet draughtless circulation. He might have discussed at greater length the results of the usual practice of re-circulating a proportion of the used air after dilution with freshly conditioned air. This arrangement is acceptable so long as the re-circulation takes place to and from a single room, but if it is adopted for a group of state rooms, every room receives a share of its neighbour's exhalations.

Although air conditioning at sea presents special problems, in certain respects a ship has advantages over a building. The filtration of dust, for example, and the troubles due to accumulation of dust in ventilating ducts, while not wholly absent in ships, are less serious matters than on land. Again, many ships already carry refrigerating plants used for food transport, which, while designed for temperatures below human comfort, can efficiently provide brine for air conditioning. It should be economically practicable to conserve, by means of ventilating heaters, some of the heat from boilers or engines that at present is wasted. The inexhaustible supply of free cooling-water from the sea is a further considerable aid in marine air conditioning. One of its consequences, to which Mr. Glass drew attention, is that it encourages the use of the steam-jet vacuum refrigerating machine, which, on account of its compactness, light weight and simplicity, is eminently suitable for comfort cooling in ships. Finally, ships carry engineers who can be relied upon, not merely to get the utmost out of air-conditioning plant, but to experiment with it, modify it and improve it, and gradually to accumulate the practical knowledge which is essential to the advancement of design. For the duration of hostilities British designers must suffer the disadvantage of being largely restricted to utilitarian building, but it is certain that air conditioning will be a most important item in post-war shipbuilding.

NOTES.

THE WORK OF THE INSTITUTION OF ELECTRICAL ENGINEERS.

THE annual report for the year ended March 31, 1940, which was presented at the sixty-eighth annual general meeting of the Institution of Electrical Engineers, on Thursday, May 9, records that the membership now amounts to 19,872, an increase of 828 during the year under review. The Meter and Instrument Section had 733 members, the Transmission Section 1,683, and the Wireless Section 1,087 members, while there were 4,392 students. The co-operation between the Institution and the Ministry of Labour and National Service resulted in the placing of 5,540 volunteers on the Central Register, and of 260 on a subsidiary register, containing students with qualifications or experience in telecommunications. Before the war, the Institution made an arrangement with the War Office to ensure that members called up would be posted to technical branches of the Forces, and it is reported that this procedure has been entirely successful except in a few cases. Another war-time activity was the setting up of a special committee to assist the Ministry of Home Security in electrical matters, and this body has assisted the British Standards Institution in the preparation of specifications dealing with the electrical equipment of air-raid shelters. At the beginning of the war, it was agreed by the Council that every effort should be made to carry on as many of the activities of the Institution as possible, and that the library and headquarters should remain at Savoy-place. With considerable reluctance, however, it was felt to be advisable to cancel the programme of the London meetings for the first half of the session, and this example was followed by the local centres. Nevertheless, in the light of the existing situation, and in deference to the growing desire for more active interchange of views, meetings were resumed at the end of January, and since then the full programme has been carried out both in London and the provinces. Attention is called to the fact that the normal activities of the Engineering Public Relations Committee have been suspended during the war.

THE COMMITTEE ON MATERIALS TESTING.

The Joint Committee on Materials and Their Testing has presented a report on its third year's working to the 26 British institutions and societies which are represented upon it. At the annual meeting, held on March 22, 1940, Sir Harold Carpenter, F.R.S., was unanimously elected chairman in succession to Dr. H. J. Gough, F.R.S. Engineer Rear-Admiral W. M. Whayman, C.B., was elected deputy chairman, and Mr. G. H. Ford, M.Sc., was re-appointed as secretary. No meetings of the full committee were held, but the sub-committee, appointed to deal with papers, met to consider the detailed arrangements for the Third General Discussion, which was to have been held in November, 1939, on "The Properties and Testing of Heat-Insulating Materials." This discussion, for which four papers had been arranged, was organised in conjunction with the Institution of Gas Engineers, and Dr. W. T. K. Braunholtz, of that institution, had agreed to take the chair. Owing to the war, it was deemed advisable to cancel the discussion, but, the report states, most of the authors had expressed their willingness to reconsider their papers when conditions made it practicable for the function to be held. Proposals were also under consideration for future discussions, to be arranged jointly with the Society of Glass Technology and the Textile Institute. Present difficulties have prevented further progress with these tentative arrangements, but the possibility of holding a meeting in the provinces, in the autumn of 1940 or the spring of 1941 are being examined. Dr. H. J. Gough, although he has resigned the chairmanship of the Joint Committee, continues to represent Great Britain on the Permanent Committee of the International Association for Testing Materials. A meeting of this Permanent Committee had been arranged to be held in Naples in April, 1939, but had been postponed on account of the unsettled conditions then prevailing in international affairs. For the same reason, it was decided not to proceed with the preparations to contribute papers by British authors to the 1940 Congress, which was to have been held in Munich. The Joint Committee has provisionally accepted a proposal that the surplus of about 1,588*l.*, remaining after the London Congress of 1937, should be transferred to trustees, to further the aims of the Joint Committee, with special reference to future International Congresses.

ELECTRICITY SUPPLY IN NEW SOUTH WALES.

The Return of Engineering and Financial Statistics of Electricity Supply Undertakings in New South Wales for the year ended December 31, 1938, which has been issued recently by the Electricity Advisory Committee Department of Works and Local Government, Sydney, bears a close resemblance to the similar document which is published by the Electricity Commissioners in this country. It covers 125 government and municipally-owned undertakings and 69 concerns which are in private hands. The information given for those undertakings which fall into the first category include a statement of assets, generating expenses, the amount and cost of the energy generated or purchased, the distribution expenses, and other costs, and the amounts sold for domestic, commercial, street lighting, power and other purposes. Other data includes the number of consumers and the energy sold per head of population and consumer, as well as technical information relating to the generating and transforming plant, transmission lines, maximum load and load factor. The similar figures given for the privately-owned undertakings are not so detailed, so that direct comparison is difficult, but with the exception of the Electric Light and Power Supply Corporation, which supplies a portion of Sydney, none of these bodies is of any great size. This is brought out by an examination of the summary tables, which show that, while the energy generated by the Government undertakings and local authorities amounted to 1,692·28 million kWh, that generated by the companies was only 123·94 million kWh. The total of 1,816·22 million kWh compares with 1,400·46 million kWh for the year 1937. The total electricity sold to 552,210 retail consumers was 1,335·69 million kWh. Of the Government and municipal total, 619 million kWh were generated by the Department of Railways, most of which was used for traction purposes in the neighbourhood of Sydney. In addition, the Sydney County Council generated some 683 million kWh.

RECENT COURT CASES.—VI.

By W. SUMMERFIELD, M.A., B.C.L., LL.B.

Who Are Factory Occupiers?—The Factories Act, 1937, imposes penalties upon occupiers of factories who fail to comply with its requirements designed to secure the safety of their employees. A wide connotation is ascribed to the term "factory"; who is the "occupier" often provides a difficult problem; and both of these topics have arisen for consideration in *Rippon* v. *Port of London Authority and J. Russell and Company*. Section 151 of the Act declares that "any yard or dry dock in which ships or vessels are constructed, reconstructed, repaired, refitted or broken up" is to be included in the expression "factory." The term also includes premises in which the like processes are carried on in relation to locomotives or other plant for use for transport purposes, as well as premises in which articles are made or prepared incidentally to the conduct of building operations or "works of engineering construction." Further, any line or siding used in connection with a factory is to be deemed part of that factory. The term "workshop," which was included in the earlier legislation, was omitted from the 1937 Act.

The plaintiff in this case was a foreman boilermaker who was employed by J. Russell and Company, a firm of ship repairers. In the course of his employment, he was going to a steamship undergoing repair by his firm in a dry dock at Millwall, which had been hired by the firm from its owners, the Port of London Authority. Owing to a defect in the steps giving access to the dock, the plaintiff fell and sustained injuries, in respect of which he claimed damages, alleging against the defendants, or one or other of them, negligence and/or breach of statutory duty. He succeeded against both of them, and Mr. Justice Tucker, in the King's Bench Division, awarded him 3,355*l.* damages, apportioned between the defendants; three-fourths against the first of them and one-fourth against the second. A great deal of argument in the case was addressed to the question, Who was the "occupier"? By Section 130 (1) of the Act, the occupier is guilty of an offence in the event of any contravention of any of the provisions of the Act or of any Regulation or Order made under it—except in special cases expressly provided for in the Act, in which the owner is held responsible. A fine of 20*l.* may be incurred for any such offence, and 5*l.* per day if the offence is continued after conviction (Section 131).

Sections 25 and 26 of the Act contain provisions relating to the construction and maintenance of floors, passages and stairs, and the provision of safe means of access and safe place of employment, including the following:—(*a*) All floors, steps, stairs, passages and gangways shall be of sound construction and properly maintained. (*b*) A substantial hand-rail must be provided and maintained for every staircase in a building or affording a means of exit from it. In some cases, there must be a hand-rail on both sides of the staircase. (*c*) Openings in floors must be securely fenced and ladders must be soundly constructed. (*d*) Safe means of access to every place at which any person has at any time to work must be provided and maintained so far as is reasonably practicable. (*e*) Where a person is to work at a place from which he is liable to fall a distance of more than 10 ft. unless there is a secure foothold and, where necessary, also a secure handhold, means are to be provided to ensure his safety, so far as may be reasonably practicable, by means of fencing or otherwise.

The condition of the steps, said the Judge, was, at the date of the accident, really ruinous; they were situated in the middle of the dock and, owing to that situation, were liable to receive damage from ships bumping against the side of the dock; owing to continual damage they had begun to crumble away. The plaintiff was going down the steps along their outside edge, carrying some welding equipment weighing about 3 lb., the inside position (nearest to the hand-rail) being occupied by a man who was coming up. As he was going down, a loose portion of a step gave way under his foot, causing him to fall. The condition of the stairway, therefore, constituted a statutory breach under the Act, so that the plaintiff established liability to himself: but against whom?

The Shipbuilding Regulations, 1931, made under the Factory and Workshop Act, 1901, were preserved by the 1937 Act. They provide that "it shall be the duty of the occupier to comply with Parts I to VIII" of the Regulations; and Part I, Regulation 1, provides that "safe means of access shall be provided to all parts of the ship to which persons employed may be required to proceed in the course of their employment." There was a breach here, therefore, of the Statutory Regulations also. The Regulations specify, however, that "when a ship is being repaired in a public dry dock, the person who contracts with the owner of the ship or with his agent to execute the work of repair shall be deemed to be the occupier for the purposes of Parts I to VIII, and it shall be his duty to comply with the said Parts."

"Occupier" is not defined in terms by the Act; therefore the circumstances of each case must be looked to. The terms upon which the second defendants in this case had hired the dry dock from the first defendants precluded the second defendants from repairing the defective step, had they been minded to execute the work. The first defendants, it appeared, retained throughout possession and control of the dock and were its "occupiers" for the purposes of the 1937 Act, although they granted use of it to the second defendants upon the terms and conditions (no fewer than 34 sets) printed on the back of the application form completed by the second defendants. These terms, as so endorsed, comprised the contract subsisting between the two defendants. Having regard to the Shipbuilding Regulations and the proviso specified, the second defendants (the repairers) were to be regarded as

"notional" occupiers for the limited purposes of Parts I to VIII of those Regulations. Both defendants were liable to the plaintiff, therefore, but the second defendants were entitled to a contribution from the first defendants; this was assessed in the proportions already mentioned. Another important recent case on this topic which, however, concerned shipbuilding and not ship-repairing, was *Smith* v. *Cammell Laird and Company, Limited* (1940).

Reckless Risks.—Few phases in the whole of our statute law, and certainly none in connection with employees engaged in works involving physical risk, have given rise to so much case law as that in the Workmen's Compensation Act, 1925, "arising out of and in the course of his employment." The case of *Seviour* v. *Somerset Collieries, Limited*, well illustrates the type of difficulty which frequently confronts employers in all sections of engineering industries which are conducted in circumstances peculiarly liable to raise these problems. Is a workman disentitled to compensation if he sustains injury through a reckless or dangerous and forbidden manner of attending to his duties? The Court of Appeal, overruling the decision of the County Court Judge, has held that such misconduct of the workman does not disentitle him if he was acting in connection with and for the purposes of his employer's business.

Seviour, aged 19, was employed as a carting-boy at a coal face, which was 180 yards from the shackling point at the bottom of the haulage road. Two legible notices (in 1-in. lettering) were exhibited at that point, declaring that "no unauthorised person is allowed on the haulage road while the haulage is in motion." A stationary haulage engine was worked by an engine-driver at a point some 400 yards from the shackling point, and the engine-driver and the shackler were able to communicate with each other both by telephone and by signal. The gradient of the road up to the engine was 1 in 6. Seviour's case was that he was injured when walking up the road while the rope was in motion; he was struck by a journey of two full tubs.

Special legislation provides against various types of dangerous operations for particular industries or processes, and such special provisions must be looked to in each case which arises for determination. In this case the relevant statutory provision is contained in Section 43 of the Coal Mines Act, 1911, which enacts that no person other than (*a*) an official of the mine, or (*b*) a person employed on the road in connection with the haulage, or (*c*) a person engaged in executing repairing work requiring immediate attention, may travel on foot on any haulage road while the haulage is in motion if the haulage is worked by either gravity or mechanical power, except where the precautions detailed in the Section are complied with. Those precautions include requirements as to clear space between the side of the road and the tubs, the rate of haulage and the like. The Section further provides against travelling on sets or trains of tubs, where the haulage is worked by gravity or mechanical power, except for (*a*) the driver of a locomotive, (*b*) men being conveyed to and from work with the written permission of the management, and (*c*) a person travelling for the purpose of detaching or attaching tubs from or to the haulage rope. In breach of those statutory prohibitions, it was stated in this case, workmen frequently walked along the road when the rope was in motion. Seviour, it was deduced, had sufficient time to enter a manhole after hearing the journey coming behind him, as it was travelling at 2¾ m.p.h.; in fact, his brother, who was following him, escaped injury. It was deduced, further, that he had been riding on one of the tubs, in view of the nature of his injuries; there was no direct evidence as to the details of the accident. The County Court Judge held that a distinction could be drawn between an act of disobedience to instructions on the part of an employee and an act whereby the employee seeks to avoid some fatigue for himself, as by riding instead of walking.

Section 1 (2) of the Workmen's Compensation Act, 1925, provides that an accident is to be deemed to "arise out of and in the course of" his employment notwithstanding that the workman, at the time of the accident, was acting in contravention of a statutory regulation or his employer's instructions, if he acted "for the purposes of and in connection with his employer's trade or business." A similar provision is made in cases where the employee was acting without instructions from the employer. A great many cases have been before the Courts since 1925, in which varying views have been expressed as to the extent of the change in the law thereby introduced. In this case, for example, no fewer than twenty-one leading cases were referred to and discussed in the County Court. At the time of the accident, Seviour was going to the pit-bottom at the end of his shift. In *Thomas* v. *Ocean Coal Company, Limited* (1933), the view was expressed in the House of Lords that, in one sense, every method of performing an operation in the course of employment is an "added peril" if it is not the safest method, but, it was pointed out, the Act does not exclude from benefits where the accident arose through a method of work which was not the safest in the circumstances.

Other cases on this problem (indicating the range of industries affected) include:—*Victoria Spinning Company (Rochdale), Limited* v. *Matthews* (1936); *Lancashire and Yorkshire Railway Company* v. *Highley* (1917); *Stephen* v. *Cooper* (1929)—a farm servant injured by the cutting blade of a reaping machine; *Harrison* v. *Associated Portland Cement Manufacturers, Limited* (1939)—a workman drying sacking, used to keep his trousers dry, near an electric fan, caught his hand in the revolving fan. In the last-mentioned case, the employee's work involved standing in water, and the House of Lords held that the question of negligence, whether great or small, is irrelevant if the act which the workman was seeking to do was within the scope of his employment; as Lord Atkin put it, "no amount of negligence in doing an employment job can change the workman's act into a non-employment job."

THE IRON AND STEEL INSTITUTE.

(*Continued from page* 489.)

CONTINUING our account of the recent annual meeting of the Iron and Steel Institute, we have now to deal with the papers considered when the meeting was resumed at 2.30 p.m. on Thursday, May 2.

CORROSION RESEARCH AT CAMBRIDGE UNIVERSITY.

The "Report on Corrosion Research Work at Cambridge University Interrupted by the Outbreak of War," by Dr. U. R. Evans, was the first contribution taken. In presenting it, Dr. Evans said that the outbreak of hostilities had unfortunately caused the abandonment of much of the research into corrosion which had been proceeding at Cambridge University through the support of the Corrosion Committee and the Alloy-Steels Research Committee of the Iron and Steel Institute and the British Iron and Steel Federation. It had been thought desirable, however, to set forth the conclusions reached tentatively at the time of this abandonment, although, on some points, the opinions must be put forward with reserve. Dr. J. N. Agar's explanation of the potential distribution, close to the surface of zinc partly immersed in chloride or sulphate solution, showed definitely that electric currents were passing between a cathodic zone, situated in the well-aerated region at the meniscus, and an anodic zone below it. Visible corrosion was always associated with the zone which the electrical apparatus showed to be anodic. A convenient criterion of the protective character of a film was the amount of acid which must be added to copper nitrate to cause deposition of copper when a drop was placed on an iron surface. The author's own comparative tests on heat-tinted and other specimens of carbonyl iron had confirmed the belief that iron carrying interlocked oxide was better protected than iron carrying somewhat thicker films where the interlocking was less. Dr. J. E. O. Mayne's attempts to obtain, by means of water-emulsification, a rust-inhibitive priming paint suitable for application (*a*) to steel wet with water, and (*b*) to steel partly weathered so as to carry broken scale, rust and iron salts, appeared to have succeeded, so far as objective (*a*) was concerned, although prolonged outdoor tests would be needed before definite claims could be made. At the time of the outbreak of the war, objective (*b*) had not been attained. Dr. A. J. Gould's work on corrosion-fatigue, of which an account had been published in 1939, was continued up to the outbreak of war; the chief new results concerned the prevention of corrosion-fatigue by means of zinc ribbon, even in cases in which the steel surface was not completely covered up. This was effective in the case of chloride solutions, but less so in that of typical tap water, owing to its lower electrical conductivity.

The discussion was opened by Dr. G. D. Bengough, F.R.S., who stated that the work on paints, by Dr. Mayne, and on corrosion-fatigue, by Dr. Gould, seemed to promise important results which might be applied industrially in the not very distant future. The next speaker, Dr. W. H. Hatfield, F.R.S., agreed that the work by Dr. Mayne might well more than justify all the support that could be given to the Cambridge University Laboratories.

Mr. T. H. Turner commented on the reference in the paper to results which indicated that admirable protection could be obtained over long periods, even in severely-polluted atmospheres, provided that inhibitive paint, followed by two suitable coats—chosen for their mechanical properties—had been applied to a surface free from moisture, scale, rust and salt. He asked what was meant by "two suitable coats." He had found great differences in the behaviour of subsequent coats applied on top of red-lead paint; unsatisfactory coats, on red lead, seemed to be mostly those with glossy surfaces and those which gave exceptionally long life generally consisted of iron oxide on red lead. In a brief reply, Dr. Evans said, with regard to the point that glossy paints had not served very well, it had been found, in some early work, published at Cambridge in 1925, that, under some conditions, hard, elastic coats behaved very much worse than relatively soft coats. If rusting commenced at a weak place, stresses were set up, as a result of which the whole of a very elastic coat might flake off. A soft coat, on the other hand, would often give way until the danger had passed; then rust would, to some extent, fill up the gap and perhaps things would settle down and become quite stable. Another point was that inhibitive pigments, embedded in a very waterproof vehicle, no longer acted as inhibitors. If, for example, the red lead were embedded in a synthetic resin which was entirely waterproof, the benefit of the pigment's inhibitive properties would not be secured.

THE DAMPING CAPACITY OF STEEL.

The second paper taken on Thursday afternoon was by Dr. G. P. Contractor and Professor F. C. Thompson, and dealt with "The Damping Capacity of Steel and its Measurement." When presenting the contribution, Professor Thompson stated that the Föppl-Pertz apparatus for the measurement of damping capacity had been found to yield unduly high values, mainly as the result of frictional losses between the stylus and the recording medium. To eliminate these, the instrument had been modified so as to employ an optical recording device. The work was of an exploratory nature and no attempt had been made to deal theoretically with the experimental results. We hope to reproduce this contribution in a subsequent issue.

The discussion was opened by Dr. S. L. Smith, who agreed with the authors that any kind of mechanical recording method involved very high energy losses, and that the only method useful in this type of work was the optical one. Some of the authors' specimens had been used for a whole group of stress tests, so that it was necessary to bear in mind, at each test, the previous stress history of a specimen. It would be interesting to know whether the same results would be obtained if a different specimen were employed for each test. The sudden increase of damping capacity occurring in all the materials tested at temperatures of between 250 deg. and 300 deg. C. was truly remarkable. The next speaker, Mr. T. F. Russell, thought that the paper should have been entitled "The Study of the Low-Temperature Abnormalities of Steel from the Decay of Torsional Vibration." He

emphasised the importance of the effect of prestressing the specimens below the fatigue limit (as distinct from the overstrain mentioned by the authors), and suggested that if all the test pieces had been put into the so-called cyclic condition before the tests, the results might have been appreciably different from those reported. The last speaker, Dr. S. A. Main, stated that the implication from the authors' results was that steel became completely dead, from a tuning-fork point of view, at 300 deg. C. He had experimented with a carbon steel, heating it at 300 deg. and cooling gradually by stages, and had not found that, at any point, the steel did not give a clear and durable ring. The authors, however, were concerned with torsional vibrations, whereas his test had been concerned with waves of tension and compression, and this constituted perhaps the whole difference between the two experiments.

In a brief reply, Professor Thompson said that the initial stress in the tests had been adjusted so that the elastic limit was not reached. Consequently, the authors had felt justified in using the specimens more than once, in view of the expense involved in preparing specimens. They had used, however, eight or nine specimens of each of the materials, and the variation found was practically that of experimental error. If it were possible financially, it might be desirable to employ individual specimens for each test, but he felt that the costs would outweigh the advantages of so doing. The results given in the paper were not claimed to be more than a record of the work done, and did not represent all the work that could be done on damping capacity. In reply to Dr. Main, he said that they had expected to find the same kind of results which Robin had obtained in his acoustical work, but the curves did not coincide with Robin's results. He did not know why there should be a difference between the results of the acoustical and the mechanical experiments, but he had no reason to doubt the accuracy of the abnormal results at high temperature, as recorded in the paper.

Estimation of Hydrogen in Metals.

The last paper on the agenda for the afternoon session on May 2 was a contribution by Dr. W. C. Newell on "The Estimation of Hydrogen in Steel and Other Metals." This contribution will be found on page 479, *ante*.

Dr. T. Swinden, who opened the discussion, emphasised that the essential feature of the paper was the substantial agreement between the results of the vacuum-fusion and vacuum-heating methods. The apparatus designed and employed by the author would render the determination of hydrogen of more general application than it would be if the expensive vacuum-fusion method had to be relied on. The results for hydrogen had been reported as percentages by weight, whereas, at present, the Oxygen Sub-Committee preferred figures given in the form of milli-litres per 100 grammes. The last speaker, Mr. H. A. Sloman, pointed out that whereas the gas in steels consisted almost entirely of hydrogen, and, therefore, required no analysis, he had evidence that, in the aluminium alloys, the gas was by no means 100 per cent. hydrogen. In 1937 he had made vacuum determinations on one of the steels mentioned in the paper, and on repeating the test, in the following year, had obtained the same result. If these results could be further confirmed, they afforded interesting proof that hydrogen was not lost from the steel in the cold, at all events after the first few weeks following manufacture. Briefly replying to the discussion, Dr. Newell stated that he had not carried out much work on aluminium alloys but had found that the gas did not come off very well from the solid. A quite simple method of eliminating all gases other than hydrogen was the employment of an activated-charcoal pocket. The effect of maintaining samples at room temperatures would be studied in future work, as well as the elimination of hydrogen from steels at temperatures below 400 deg. C. At these lower temperatures the rates of evolution were much smaller, but the hydrogen elimination was definitely measurable owing to the great accuracy of the apparatus.

(To be continued.)

LETTER TO THE EDITOR.

THE KADENACY SYSTEM OF SCAVENGING.

To the Editor of Engineering.

Sir,—The recent letter on the above subject, from Dr. S. G. Bauer, printed on page 443 of your issue of April 26, appears to me to raise several points of considerable interest, and I should be grateful if you would allow me space to make some observations regarding certain of his conclusions. Dr. Bauer expresses himself in agreement with the assumption—which he attributes to Professor Davies, though he gives no reference—that ". . . only the duration, but not the magnitude of the depression created by the sudden discharge from a vessel, is influenced by the existence and length of a discharge pipe." Such a definite statement as this is obviously deserving of very careful examination both with regard to its theoretical and its practical implications, and, in particular, its bearing on the controversy which has arisen regarding the relative importance of the ballistic discharge and the negative reflection from the open end of the exhaust pipe in engines depending for improved scavenge on the utilisation of the energy of the exhaust gases.

Assuming that the term "magnitude of the depression" in the statement referred to above means the maximum instantaneous amplitude of the vacuum pulse produced in the exhaust system, the statement appears to the present writer to imply that, within limits at all events, a decrease in exhaust-pipe length must correspond to a decrease in vacuum period, and vice versa. Clearly, if the vacuum is to be effective for scavenging purposes, its duration must not be less than a certain proportion of the period during which the inlet ports are open. If the exhaust-pipe length is so short as to make the duration of the depression much less than this critical value, then the depression is useless for practical purposes, although its "magnitude" may be as large as before. With an exhaust pipe of zero length—a condition impossible to attain in practice—the duration of the vacuum period would also be zero. The above reasoning would seem to give considerable support to Dr. Mucklow's contention that the presence of an appreciable vacuum depends on the existence of an exhaust pipe. It may be objected that a decrease in exhaust-pipe length can be compensated for by changes in the valve timing of the engine, but such changes can only be carried out over a very limited range, particularly in the case of a slow-speed engine where the most suitable exhaust-pipe length would be considerable.

Dr. Bauer, in discussing the performance of a Kadenacy engine from which the exhaust pipe had been removed, states that ". . . . there was no doubt about a very powerful suction effect in the inlet manifold." Such a statement, by itself, has but little meaning, since a powerful suction effect in the inlet manifold is not an uncommon phenomenon. Perhaps Dr. Bauer could give more details on this point, and at the same time confirm that by "exhaust pipe" he means the pipe between the exhaust valve and the engine silencer or expansion chamber, and not the pipe leading from the silencer to the atmosphere. It is probably unnecessary to remark that it is well known that a tuned ramming pipe on the induction side of an engine can give a considerable increase in performance, but it may be as well to mention that if the ballistic discharge at exhaust is to be investigated, other variations due to the presence of pressure fluctuations occurring in induction pipes must first be eliminated by the removal of any such pipes.

The writer is not qualified to deal with the points raised regarding the interpretation of the results obtained from Dr. Mucklow's explosion-vessel apparatus, but he was surprised to see an objection raised on the grounds that the temperature in the vessel was lower than that occurring at exhaust in a real engine. Admittedly, in the latter case the escaping gases have a much larger thermal energy, but the influence of this, apart from increasing the velocity of propagation of waves in the gas, would seem to be doubtful.

Dr. Bauer gives no guidance as to the way in which he would expect the duration of the depression in the exhaust pipe to vary with the pipe length. It is of little use to state that the duration of the depression is "influenced by the existence and length of a discharge pipe" unless more precise information is given. Working on the assumption that the vacuum in the exhaust system of a two-stroke engine is chiefly dependent on the production of pressure waves in the exhaust pipe rather than on the presence of the ballistic discharge, the writer believes it is possible to forecast good or bad exhaust systems, to give simple rules regarding the most favourable exhaust-pipe length, and to synthesise with a fair degree of accuracy, indicator diagrams taken in the exhaust pipes of such engines. Until more information is available regarding the theoretical considerations underlying the design of the exhaust system of engines employing the Kadenacy system of scavenging, and while so many of the phenomena observed can apparently be otherwise accounted for, so long will doubts exist as to the importance of the ballistic discharge, and perhaps even as to its very existence.

In conclusion, it must be emphasised most strongly that the fine performance figures quoted for engines of Kadenacy design are not, of course, in question. Those responsible for these engines are to be congratulated on the results they have achieved, and, whatever other results the present discussion may have, it will at least have served to make widely known a real advance in two-stroke engine design.

Yours faithfully,
L. J. Kastner.

Hawthornden,
Marple, Cheshire.
April 29, 1940.

THE PORT OF NEW YORK.

Radical changes in the world trade situation, due to the war in Europe and to the application of the Neutrality Act in the United States, do not appear to have affected adversely the operations of the Port of New York Authority. Statistics issued by this body, in its recently issued annual report for the year ended December 31, 1939, show increases in all directions over the corresponding figures for the preceding year, the gross revenues being improved by 10·4 per cent., to a total of 16,162,583 dols. The George Washington Bridge, with 8,063,356 vehicles, the Lincoln Tunnel, with 2,845,349 vehicles, the Holland Tunnel, with 13,330,681 vehicles, and the Bayonne Bridge, with 560,515 vehicles, each handled more traffic than in any previous year. The total vehicular traffic over all the facilities administered numbered 25,740,815 vehicles, an increase for the year of 10·1 per cent. The opening of the express-highway approach to the New Jersey terminal of the Lincoln Tunnel, in particular, increased the use of this traffic link, by 53·8 per cent.

This connection of the Lincoln Tunnel through Union City and North Bergen, in New Jersey, was put into service on June 30, 1939. Built at a cost of 12,568,000 dols., it consists of a six-lane roadway flanked by marginal streets. Where it traverses the plateau on the New Jersey side of the Hudson River, it runs below the level of the surface streets, which cross it on bridges. West of Hudson County Boulevard, in North Bergen, it descends on a viaduct to join with arterial roads. Access to this Boulevard is given by a three-level structure, a feature of which is an interchange circle at an intermediate level; and two other connections with the surface streets are provided for non-tunnel traffic using the express highway. The southern marginal street was opened for traffic on May 1, and the northern one on June 9. A "loop" structure in Weehawken, to carry tunnel traffic from the tunnel toll-area to the beginning of the depressed highway, was completed in October, 1938, some ten months after the opening of the first completed tunnel-unit on December 22, 1937. The full effect of the tunnel is not likely to be realised until other approach-roads contemplated in the design have been built in New Jersey. For present requirements, therefore, a single tunnel-unit carrying two-way traffic is sufficient and construction of the second has been discontinued. It is so far advanced, however, as to be capable of being completed in another 30 months. The estimated cost of this additional section is 11,500,000 dols.

Work upon the New York approaches to the George Washington Bridge was already well advanced when the year opened. The anchorage of this new suspension bridge has now been encased in granite rubble masonry, and all work upon it and the adjoining ramps was completed last November. The arch over Riverside Drive has been widened to enable it to carry two roadways, flanking the central roadway, which lead from the bridge on to Fort Washington-avenue. The central roadway itself leads into Amsterdam-avenue via the 178th-street Tunnel, which was paved and finished early in the year. It is expected that the approach structure, linking Amsterdam-avenue and the 178th-street Tunnel portal with the Harlem River Speedway, will be opened in the spring of this year. This consists of a reinforced-concrete arched viaduct, descending along the steep hillside of Highbridge Park. The viaduct was about three-quarters completed at the end of last year.

While the Authority is best known by reason of its responsibility for New York's inter-State tunnels and bridges, it is charged by statute with several other functions. It plays a leading part in upholding New York's status as America's greatest port, and, to this end, takes a close interest in the activities of various commerce-regulating bodies, countering competitive moves attempted by other ports, and seeking to

improve local transport facilities and to unify freight-terminals where possible. It advises municipalities on terminal matters and recommends to the Federal authorities channel improvements likely to benefit waterborne traffic. It has been instrumental in securing a Federal grant for modernising the New York State Barge Canal, an essential feeder which serves in the same relation to the port as the Mississippi or St. Lawrence rivers to New Orleans and Montreal, respectively. Proposals for a fixed bridge, having minimum headway of 135 ft. and a clear span of 1,600 ft. across the East River from the extreme tip of Manhattan to Brooklyn, have been rejected by the War Department on the ground that national defence requires that no obstructive crossing should be built at that point which lies to seaward of the Brooklyn Navy Yard.

GAS-ENGINE CONTACT MAKER FOR TROPICAL SERVICE.

Special precautions have usually to be taken in the design of machinery for the tropics, owing to unfavourable climatic conditions, the possibility of small insects finding their way into delicate mechanism, and the preponderance of unskilled labour. These factors, in particular, have influenced the design of the ignition apparatus for a 1,600-b.h.p. gas engine, operating on natural gas, recently supplied to the West Indies by Messrs. Crossley-Premier Engines, Limited, Sandiacre, Nottingham. The ignition apparatus, which was designed and manufactured complete by Messrs. Lodge Plugs, Limited, of Rugby, is illustrated in Figs. 1 to 4, on this page. As can be seen from the wiring diagram, Fig. 1, the ignition is by battery and coil. The engine is a horizontal twelve-cylinder model, with two plugs per cylinder. Two ten-volt nickel-iron batteries are provided to supply the low-tension current to the coils, these batteries being maintained in a fully-charged condition by a separate dynamo, indicated on the right in Fig. 1. The batteries are in parallel on the coil circuit, to which they are connected through two-way switches, and normally, only one is in use, while the other is on charge. There are two contact makers on the low-tension side, each serving six coils, and the coils themselves are of the double-output type. In this type of coil there is a single high-tension winding, both ends of which are insulated and connected to two plugs which fire in series, in contradistinction to the normal motor-vehicle practice of connecting one end of the high-tension winding to earth, the body of the sparking plug in metallic connection with the engine providing the earth pole for the spark. The pressure on the high-tension side is 1,500 volts, and as such a voltage, in tropical conditions, presents a somewhat difficult condenser problem, the plates are embedded in a special heat-resisting wax.

The two contact makers, one of which is illustrated in Figs. 2 to 4, are of particular interest. The faceplate carrying the make-and-break mechanism for each coil forms part of a rotatable sleeve mounted on a short column bolted to the engine frame, and advance or retard of the ignition as a whole is effected by rotating the sleeve on the column. For this purpose, the sleeve is provided with an arm terminating in a handle, and working against a fixed quadrant on the column, a scale and locking device being arranged as shown in Fig. 3. Apart from this control, each of the six-way contact makers incorporates micrometer adjustment for the individual timing of each cylinder. As will be clear from Fig. 2, each make-and-break mechanism is mounted on a circular segment, these segments being of fibre for the low-tension insulation. One of the contact points is mounted on a fixed bracket, while the other is mounted on a slide with a scale and micrometer adjustment. A lock-nut is provided on each micrometer screw. The adjustable arm is extended inwards to carry a roller, and, as shown in Fig. 2, the six rollers make contact successively with a cam piece let into a flange keyed to the half-speed shaft. All the fixed points are connected to a common terminal at the bottom of the faceplate, as shown in Figs. 3 and 4, this terminal being connected to the positive terminals on the batteries, while the movable contact points are connected individually to the positive terminals on the coils. As shown in Fig. 3, the connections to both the fixed and movable contact points are made on the back of the faceplate. The whole of the make-and-break mechanism is protected by a detachable dust-proof cover, as shown in Fig. 3. It should be mentioned that only one of the contact units is shown in the figure for the sake of clearness. The cylinder firing order for one contact maker is indicated by the figures in Fig. 4, the order for the other contact maker being 7, 8, 10, 12, 11, 9. Each sparking plug is 15 in. long, and the complete ignition equipment weighs nearly a ton. The coils are mounted on the engine immediately behind the cylinder heads, giving short high-tension leads to the two plugs, which are located on the vertical axes of the cylinders. The contact makers are mounted on the ends of cross-shafts located beneath the coils, so that the low-tension connecting wires, which are carried in a trough below the coils, are also relatively short, the whole assembly giving a neat and compact arrangement.

Fig. 1.

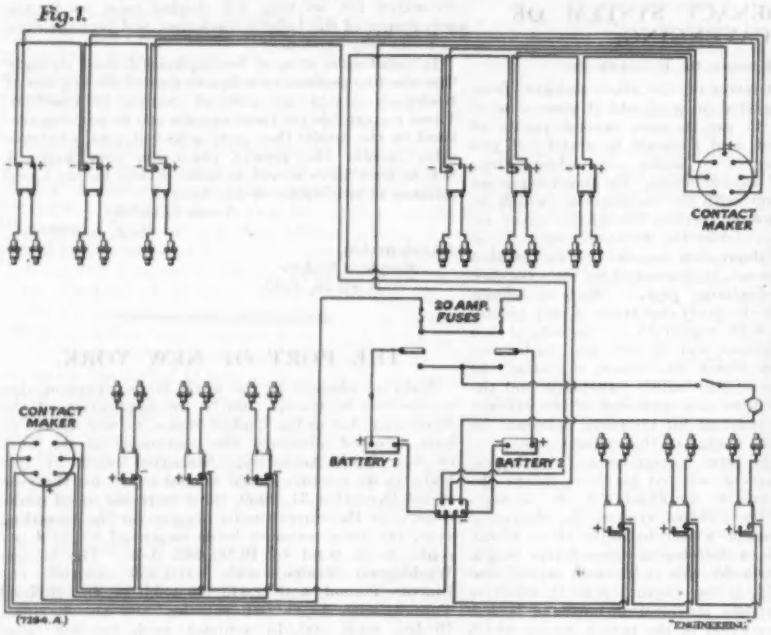


Fig. 2. Make and Break Mechanism.

Fig. 3.

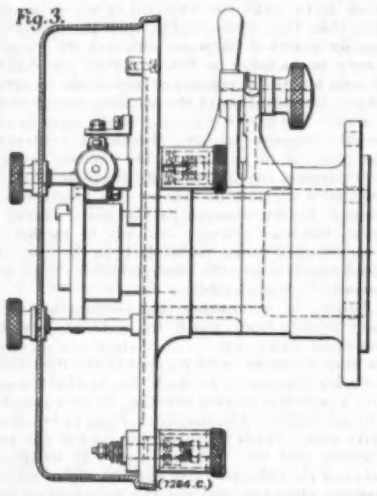
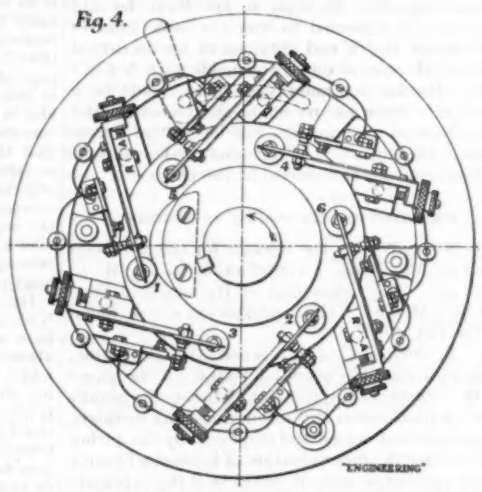


Fig. 4.



Service Candidates for Examinations for the Professions.—Personnel serving in the Royal Navy or the Royal Marines, who were students for a profession in civil life, such as law or accountancy, before joining H.M. Forces, and who desire to take an examination arranged by the society or institute governing that profession, may, if they are serving in shore establishments at home or in sea-going ships in home waters, be granted leave when service exigencies permit, at the direction of the Commanding Officer.

Development of Refugee Industries.—The Committee for the Development of Refugee Industries, 12, Buckingham Palace-road, London, S.W.1, has compiled a list of some hundreds of refugees who have held important positions, in managerial capacities, in manufacturing firms, merchant houses, etc., in connection with the export trade in Germany, Austria, Czechoslovakia, Poland and Spain. We are informed that, between them, they cover a wide variety of industries and many retail markets, in which they have personal connections. British firms or organisations interested in securing the services of these men are invited to communicate with the Committee at the above address.

THE LATE MR. W. B. ESSON.

We regret to record the death of Mr. W. B. Esson, which occurred in London on Thursday, May 9. Mr. Esson, who had reached the age of eighty-two, did useful work in the 'eighties and 'nineties of last century as a designer of the electrical generating plant of that time, and was responsible for the erection of a number of public generating stations.

William Beedie Esson was born in Aberdeen on March 27, 1858, and at the age of fifteen entered the works of Messrs. William McKinnon and Company in that city as an apprentice. On receiving his articles, he became a student at the Royal School of Mines in London, and obtained the highest award in applied mechanics. At the age of twenty he obtained a post with the Thames Iron Works and Shipbuilding Company, Blackwall, and was for a time in charge of the drawing office in the mechanical-engineering department of that firm. Here he was responsible for designing the paying-out gear for a number of cable ships and also carried out experiments on the primitive dynamos and arc lamps of the period. To increase his theoretical knowledge of this equipment, he attended the lectures which Ayrton was then giving at Finsbury Technical College, and in 1883 obtained the silver medal of the City and Guilds of London Institute in the honours grade of electric lighting and transmission of power. In the same year, he joined the firm of Messrs. Paterson and Cooper as chief electrician and became manager twelve months later. After holding this position until 1892, he left to manage the Gülcher Electric Light and Power Company, for whom he designed the plant required for electric lighting the city of Wellington, New Zealand. Two years later he became chief engineer and manager of the electric lighting and power transmission departments of Messrs. Johnson and Phillips, Limited, being responsible for the design and construction of all the electrical machinery and apparatus manufactured by that firm and for carrying out a number of electricity supply schemes both at home and abroad. One of these, which attracted great attention in those early days, was a long-distance power transmission scheme for the Sheba Gold Mines in the Transvaal. In 1904, he resigned his position with Messrs. Johnson and Phillips to engage in practice as a consulting engineer on his own account, but he retired from active life many years ago.

Mr. Esson was elected an associate of the Institution of Electrical Engineers in 1884 and was transferred to the class of member two years later. He also served for a time on the Council. He was a frequent contributor to the *Proceedings* and was awarded the Institution Premium for a paper on "Some Points on Dynamo and Motor Design." In this he enumerated the relationship between the speed and dimensions of dynamos and their output, expressing the comparative merits of machines in terms of an "output coefficient." The treatment was subsequently extended to alternators and induction motors. He was President of the Civil and Mechanical Engineers Society in 1905 and 1906, and served on the Jury of the International Electrical Exhibition in 1892.

THE LATE MR. H. J. WARD.

Mr. Herbert John Ward, whose death, we regret to record, occurred on May 2, was well known for many years as a technical director of Messrs. J. and E. Hall, Limited, Dartford, especially in connection with refrigerating plant for ships. He was 70 years of age, having been born in Belfast in 1870. He was educated at St. Mark's School, Windsor, and proceeded thence, in 1888, to Pembroke College, Cambridge, where he took a B.A. degree in 1891. His degree of M.A. (Cantab.) was awarded in 1896.

From Cambridge he went, in 1891, to the Belfast shipyard and marine-engine works of Messrs. Harland and Wolff, Limited, where he served a four-years' pupilage, leaving them in 1895 to join the technical staff of Messrs. Elder, Dempster and Company, Limited, Liverpool. During the six years that he spent with them, Mr. Ward organised and considerably developed the construction department of Messrs. Elder, Dempster and Company. In 1901, he was appointed managing director, and, in 1921, chairman, of Messrs. J. and E. Hall, Limited, Dartford. He retired in 1937 on account of ill-health. Mr. Ward was a member of the Institution of Naval Architects, the Institute of Marine Engineers, and the Institution of Mechanical Engineers, and, from 1926 to 1928, was president of the British Engineers' Association.

Society of Chemical Industry.—The 21st annual general meeting and dinner of the Chemical Engineering Group of the Society of Chemical Industry will be held on May 23 at the Waldorf Hotel, Aldwych, London, W.C.2. The meeting will be held at 6.45 p.m., and the dinner at 7.30 p.m. Those intending to be present should notify the honorary secretary, Mr. J. M. Leonard, by Monday, May 20.

LABOUR NOTES.

The Ministry of Labour and National Service states that there was a further substantial improvement in employment between March 11 and April 15. Between these two dates the number of unemployed persons on the registers of Employment Exchanges in Great Britain fell by 148,578, and the total of 972,695 registered at April 15 was the lowest recorded since the end of 1920 when the extended unemployment insurance scheme came into operation. Between April 17, 1939, and April 15, 1940, there was a reduction of 671,699.

The reduction in unemployment between March and April this year was distributed over nearly all the principal industries, the greatest reductions occurring in building and public-works contracting, the distributive trades and agriculture. There were also substantial decreases in hotel and boarding-house service, coal-mining, engineering, metal-goods manufacture, furniture manufacture, printing and bookbinding, local-government service, dock, harbour, etc., service, road transport, brick and tile manufacture, tailoring and dressmaking.

Of the 972,695 persons on the registers at April 15, 840,027 were wholly unemployed, 90,182 temporarily stopped, and 42,486 normally in casual employment; 538,570 of the wholly-unemployed were men, 21,528 boys, 243,480 women, and 36,449 girls. Of the temporarily stopped, 54,786 were men, 1,092 boys, 32,748 women, and 1,556 girls, and of the casual workers, 40,590 were men, 103 boys, 1,786 women, and 7 girls. Between March 11 and April 15, the numbers on the registers decreased by 28,759 in the London area, 10,745 in the Eastern area, 9,198 in the Southern area, 3,321 in the South-Western area, 12,278 in the Midlands, 12,764 in the North Midlands, 11,217 in the North-Eastern area, 26,132 in the North-Western area, 10,198 in the Northern area, 17,251 in Scotland, and 6,655 in Wales.

In April, the home branch membership of the Amalgamated Engineering Union increased from 395,389 to 404,843 and the Colonial branch membership from 37,184 to 37,653. The number of members on sick benefit decreased from 6,549 to 4,468 and the number in receipt of superannuation benefit from 13,860 to 13,788. The number in receipt of donations benefit decreased from 602 to 536, and the total number of unemployed members from 2,974 to 2,790.

In the May issue of the Amalgamated Engineering Union's *Journal*, Mr. Tanner, the president, mentions that a conference has taken place with the Engineering and Allied Employers' National Federation on the subject of the staggering of summer holidays. The employers intimated, he says, that their Management Board sympathised with the proposal that arrangements should be made, if possible, in local areas to meet the convenience of workers who desire to get away for a holiday. The view of the Board was, however, that the question was so dominated by local industrial and other considerations that it was quite impossible for the central bodies to make anything in the nature of a specific recommendation affecting all areas. They agreed to suggest to their local associations, therefore, that they should have the matter under review and, if necessary, discuss it with local trade-union representatives.

It is stated that, as from February 1, a war bonus is to be paid to all whole-time non-industrial Civil servants. The bonus is to be paid to those whose remuneration is 95*s.* a week or less in London, 91*s.* or less in intermediate centres, and 87*s.* or less in provincial centres, or the annual equivalents of these rates. Civil servants over 21 receiving under 40*s.* will have a bonus of 3*s.* a week. Those receiving 40*s.* to 50*s.* inclusive will get 4*s.* a week, and those receiving over 50*s.* a week will have a 5*s.* bonus. A bonus of 1*s.* 6*d.* will be given to Civil servants under 18 and a bonus of 2*s.* 6*d.* to those aged from 18 to 21. Officers whose ordinary remuneration exceeds by not more than 5*s.* the rates of 95*s.*, 91*s.*, and 87*s.* mentioned, will receive a bonus sufficient to bring their pay and bonus together up to the same level.

Increases in wages of 3*s.* a week of 47 hours for men workers and seven-eighths of a penny an hour for women were announced last week by the Stamped or Pressed Metal Wares Trade Board. There are corresponding increases to piece-workers, in overtime rates and in holiday pay. Some employers are already paying the increases, and the Trade Board hopes that all will put the increased rates into operation as early as possible without waiting for the Minister of Labour's confirming order.

The Ministry of Labour and National Service announced last week that certain of the engineering courses in Government training centres may be reduced to three months to meet the needs of industry. It is now possible to take men into employment from the Government training centres after a shorter period of training than has hitherto been required. The standard length of the course is six months, nine months for draughtsmen; but, even in peace time, it was customary to release men who had passed their trade tests after about 20 weeks of training.

Steps are being taken to confine the courses to absolute essentials in view of war-time needs, and in many cases men can be released, if required by employers, after a still shorter period. Employers desiring skilled workers should make their wishes known to the employment exchanges, and may find it useful in many cases to send a representative to the nearest training centre to ascertain the kinds and degrees of skill attained by the men under training.

The report of the General Federation of Trade Unions for the twelve months which ended on March 31 states that 92 societies are affiliated, 57 on the higher scale, 33 on the lower scale, and two on both scales. The membership on which contributions are based is 342,093, and of that number 220,499 members are on the higher scale, 111,561 on the lower scale, and 10,033 on both scales. The gross membership is 353,671. The contributions received during the twelve months amounted to 25,662*l.* 5*s.* 10*d.*, and the benefits paid out to 955*l.* 12*s.* 6*d.*

According to Mr. George Bell, the general secretary of the Federation, the reserve balance appreciated by 27,207*l.* 12*s.* 11*d.* during the twelve months. The balance sheet shows that after provision has been made for the outstanding liability for Income Tax and the reserve for depreciation of property, the net worth of the Federation at the end of March was 300,107*l.* 9*s.* 1*d.* The amount of the financial reserve constitutes, Mr. Bell says, a record in the forty years' history of the organisation. Trade disputes did not make a heavy call on the funds during the twelve months. There were 24 disputes; in the largest, 250 members were involved and in the smallest only one member was involved.

The following circular to branches and district committees is reproduced in the May issue of the Amalgamated Engineering Union's *Journal*:—"Executive council are aware that certain shop stewards of this union have attended conferences convened by a body not provided for within the constitution of, or having any connection with, the Amalgamated Engineering Union. These conferences have discussed industrial questions which are the primary function of this organisation, and have even formulated a policy intended to operate in the various workshops. This is usurping the functions of the National Committee of the union. The status of shop steward is derived from the provisions of Rule 13, and agreements concluded with the consent of the National Committee between executive council and the employers; their stewardship must be upon that basis only, and their actions must always be within the rules of the union and the agreements signed on behalf of the union."

"Shop stewards," the circular continues, "are not entitled to use their position to attend meetings convened by any unofficial body, and it, therefore, follows that they are not permitted to discuss at such meetings questions dealing with the functions of the union or to accept any instructions whatever from such sources. Executive council instruct you to inform all shop stewards under the control of your District Committee that if they, as shop stewards, attend meetings or conferences which are not convened under the authority of, or in accordance with the constitution of the union, their shop stewards' credentials will be withdrawn. Please oblige by taking immediate steps to give effect to this instruction."

Centenary of Derby Railway Works.—Derby celebrated its 100th anniversary as a railway manufacturing town on May 11. At the present time the works cover a total area of 175 acres and give employment to more than 8,000 persons, but originally they comprised a small group of buildings for the use of the North Midland and Midland Counties Railways, which with the Birmingham and Derby Junction Railway, shared the use of Derby passenger station, opened at the same time as the works. The North Midland Railway, of which George Stephenson was the engineer, was opened from Derby to Rotherham—with a connection to Sheffield—on May 11, 1840, and the Midland Counties Railway, which had been opened from Nottingham to Derby in the previous year, was extended to Leicester on May 4, 1840. The first locomotive superintendent at Derby was Robert Stephenson.

PROBLEMS OF THE SINGING PROPELLER.*

By PROFESSOR W. KERR, DR. J. F. SHANNON and DR. R. N. ARNOLD.

(*Continued from page* 472.)

THE maximum suction occurring on a blade section is controlled to a large extent by the contour of the leading edge. To study this aspect, pressure distribution experiments were undertaken in the 5-ft. diameter open-jet wind tunnel at the Royal Technical College, Glasgow. The model sections had a chord of 15 in. and a span of 24 in., and were rigidly attached at each end to brass discs supported by large vertical side-planes. The angle of incidence was adjusted by rotating the discs and locking them at the desired inclination. Pressure readings were recorded by embedding small copper tubes below the surface of the sections, a $\frac{1}{32}$-in. diameter hole being drilled in each at mid-span, normal to the aerofoil surface. These tubes were connected by rubber tubing to a multi-tube manometer. All the tests were carried out with an air speed of 120 ft. per second, giving a Reynolds number of approximately 10^6, and the angle of incidence varied from -15 to $+25$ deg.

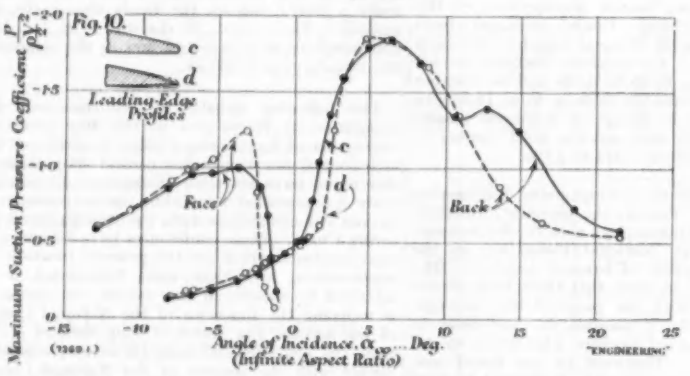
The maximum suction, the rate of recompression from suction peak to trailing edge, and the general distribution of pressure on the profile have a large influence on cavitation and breakdown of flow on the blade surface. Separate diagrams showing the variation in maximum suction with angle of incidence have been plotted in Figs. 9 and 10, herewith. Fig. 9 allows a direct comparison to be made between sections which have rounded and sharp leading edges, respectively. It is evident that the sharpening of the edges reduces the tendency to high suction within the range of angle of incidence from -3 deg. to $+3$ deg., the significance of which will be considered later. An exactly similar result, though not so pronounced, is indicated in Fig. 10. The smaller change, due to sharpening the edge of section *c*, is due no doubt to the fact that it has initially a relatively sharp leading edge. In all cases the suction pressure attains a maximum at relatively low positive and negative angles of incidence, and thereafter diminishes, this being typical of sections having a low camber ratio.

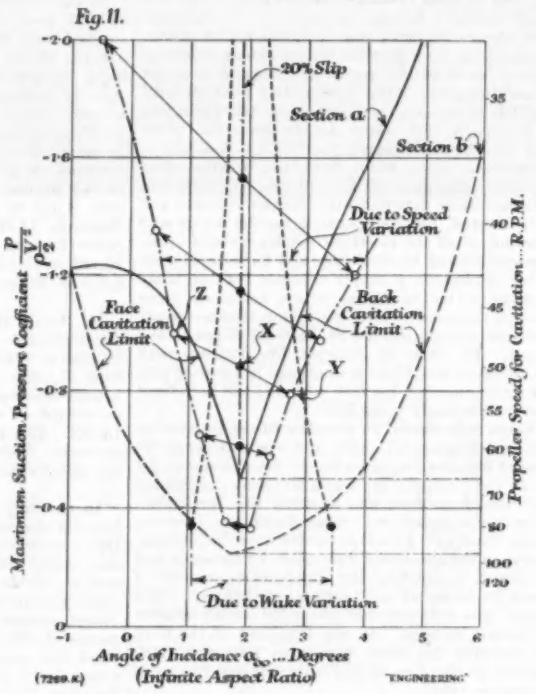
To show the practical significance of the results obtained from the wind-tunnel investigations, Fig. 11, on this page, has been prepared. Here the suction peak characteristics for sections *a* and *b* have been reproduced over a limited angle of incidence. Profile *a* is a replica of the section, at approximately 0·9 radius, of a four-bladed propeller 18 ft. 3 in. in diameter. This propeller was known to sing badly, but when the leading and trailing edges were sharpened in a similar manner to section *b* the trouble was eliminated. It was driven by a triple-expansion engine, and records of cyclic speed variation for a similar installation were available. From the conditions of cavitation it was possible to convert the pressure coefficient to an equivalent cavitation speed expressed in revolutions per minute. With full immersion and a water temperature of 60 deg. F.,

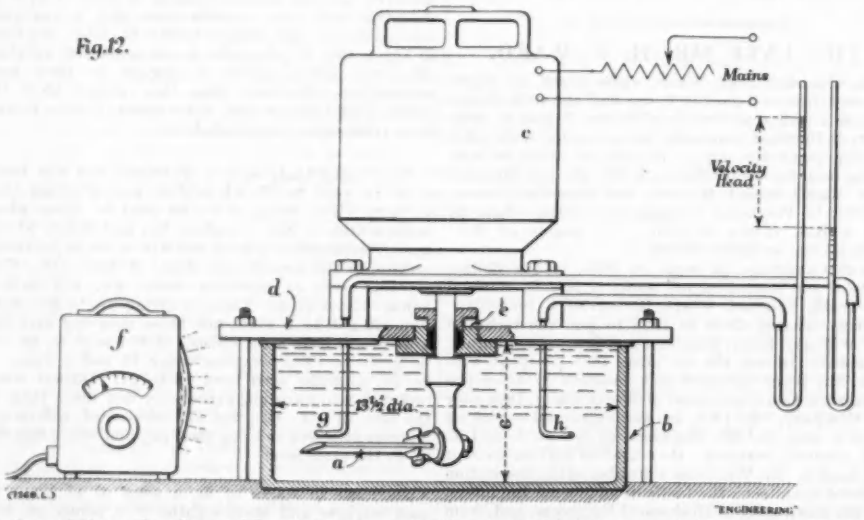
$$\frac{p}{\frac{\rho V^2}{2}} = \frac{1{,}620}{V^2},$$

where V is the velocity of water relative to blade at the section considered. Results show that the slip of such a propeller between 40 r.p.m. and 80 r.p.m. is approximately 20 per cent. The line drawn for this condition indicates that cavitation would first occur at 67 r.p.m. with section *a*, but not until 95 r.p.m. with section *b*. This, however, is only true for steady conditions, an ideal which is never attained because of wake variation and cyclic speed fluctuation. Approximate calculations, made to allow for these influences, are superimposed on Fig. 11. If point *X* represents the position for a mean speed of 50 r.p.m. and 20 per cent. slip, then, due to speed fluctuation and the angle variation which must accompany it, the maximum and minimum positions will be represented, respectively, by Y and Z. Similar maxima and minima are shown over a speed range from 38 r.p.m. to 80 r.p.m. The curve traced by these points shows that, even at low speeds, cavitation may be promoted in section *a*. In the absence of experimental data it was not possible to estimate the effect of wake variation very precisely. Some indication, however, was obtained from work by Baker (1933), and dotted lines have been plotted to show the probable variation. In view of the lack of precise information, the results of Fig. 11 must be accepted with a certain reserve. They do indicate, however, that sharpening the leading edge of the blade may suppress the cavitation limit within the working range of the propeller and thereby avoid the possibility of cavitation due to variation in speed and wake. Sharpening the leading and trailing edges in some cases has eliminated singing.

In order to study cavitation phenomena with model blade forms, the apparatus shown in Fig. 12, on this page, was constructed. It consists essentially of a blade *a* immersed in water in a glass container *b*. The blade is rotated by an electric motor *c* and is attached to the spindle by a joint which allows the angle of incidence to be varied. A steel cover *d* supports the motor, the spindle of which projects through a gland *e* to prevent air leakage. Rubber jointing between this cover and the rim of the glass container may be compressed by screws to ensure a tight joint. Visual observation of the rotating blade is accomplished by means of stroboscope *f*, which generates a pulsating light. The instrument is fitted with a graduated dial by which the light frequency may be varied from 600 to 14,000 per minute. To determine accurately the relative speed of the blade through the water, the rotational speed of the water in the container required consideration. In order to estimate this spinning action, two copper tubes *g* and *h* were inserted through the cover. These tubes measured, respectively, the static and total pressures,



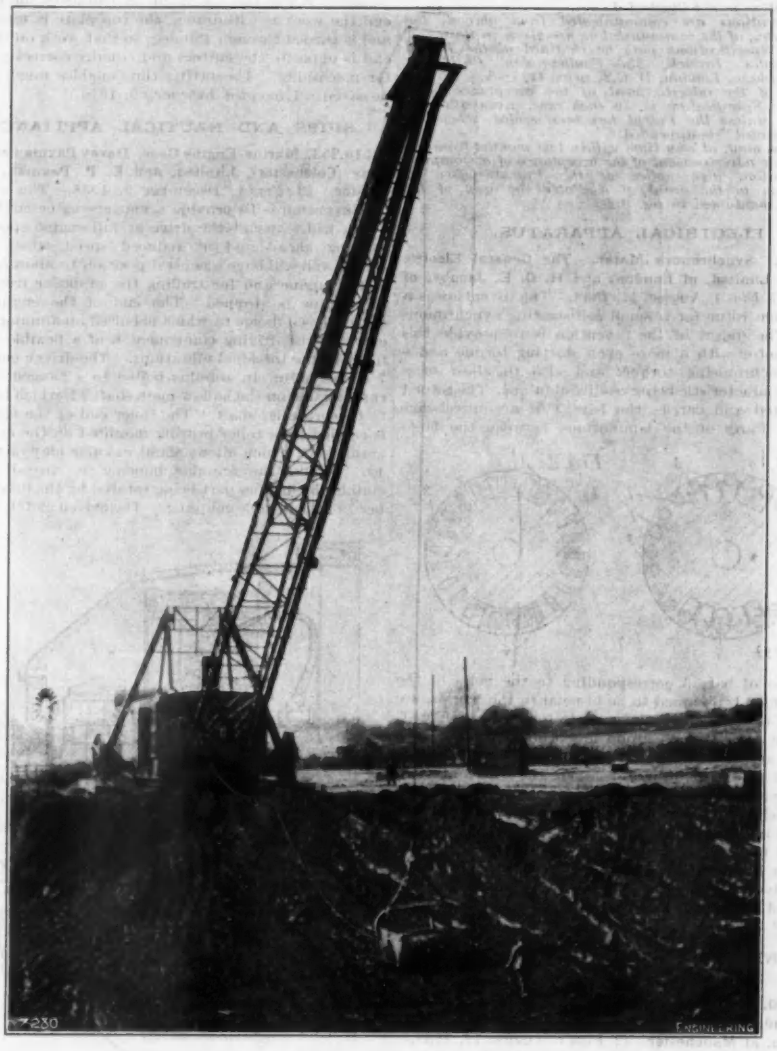




* Paper read at a meeting of the Institution of Mechanical Engineers, in London, on Friday, April 19, 1940. Abridged.

3-CUB. YD. "WALKING" DRAGLINE EXCAVATOR.

MESSRS. RUSTON-BUCYRUS, LIMITED, LINCOLN.



which were registered by water manometers. From these readings the rotational speed of the water was calculated. Knowledge of the blade speed determined from the stroboscope readings allowed the relative velocity of water to blade to be determined.

The cavitation investigations were based on visual observation, readings being taken when the formation of cavities became evident at that part of the blade directly under the pressure tubes. From a knowledge of static pressure, barometric pressure, relative blade speed, and water temperature at the start of cavitation, it was possible to determine the non-dimensional pressure coefficient $\frac{p}{\frac{\rho V^2}{2}}$ used in recording aerodynamic results. This coefficient is merely the ratio of the pressure at any point on the blade to the velocity pressure of the fluid stream. When cavitation commences

$$\frac{p}{\frac{\rho V^2}{2}} = -\left[\frac{P - p_e}{\frac{\rho V^2}{2}}\right]$$

where P denotes the absolute static pressure of water at the blade depth p_e the vapour pressure corresponding to temperature and air saturation, p the maximum suction on the blade, V the relative velocity of water to blade, and ρ the density of water. The value of p_e was taken at 3·5 lb. per square inch absolute.

(To be continued.)

BULGARIAN INTERNATIONAL COMMERCIAL FAIR.—The ninth International Commercial Fair will be held at Varna from August 17 to September 6. Information regarding the function may be obtained on application to the Secretary, Foire de Varna, Varna, Bulgaria.

3-CUB. YD. "WALKING" DRAGLINE EXCAVATOR.

ALTHOUGH an illustration of a walking dragline excavator will be found on page 223 of volume 145 of ENGINEERING (1938), it is cited, in the accompanying text, as an example of contemporary practice in the United States. The accompanying illustration, which was reproduced from a photograph taken in the ironstone quarries of Messrs. The Wellingboro' Iron Company, Limited, Wellingborough, Northants, shows that this type of excavator is now successfully in production in Great Britain. The machine is, in fact, the first walking dragline excavator to be built and installed in this country. It is one of two supplied to Messrs. Stanton Ironworks Company, Limited, near Nottingham, by the makers, Messrs. Ruston-Bucyrus, Limited, Excavator Works, Lincoln, and is known as the Ruston-Bucyrus-Monighan 5.W. type. It is fitted with a 3-cub. yd. bucket on a boom 135 ft. long and is used to strip and dump about 40 ft. of overburden. The machine is electrically-driven and is fitted with the Ward-Leonard control system. Two prominent features in the illustration are the length of the jib and the actual seating of the body of the excavator on the ground, as well as its nearness to the edge of the excavation. Both are rendered possible by the low centre of gravity obtainable with the "walking" method of propulsion.

The body of the machine, *i.e.*, the superstructure containing the operating mechanism and the bottom frame on which the superstructure is carried, rests squarely on the ground when digging is being done, but not when the machine is being traversed. As the bottom frame consists of a strongly-built steel structure 21 in. deep and 24 ft. in diameter, the total weight is spread over a large area and the pressure on the ground is only some 5 lb. or 6 lb. per square inch, or only about 25 per cent. of the ground pressure of the crawler tracks that would be fitted to a machine of this capacity. This low bearing pressure enables the excavator to be employed on soft ground and close up to the cut-back face. The machine weighs about 150 tons.

The walking mechanism consists of a pair of large flat rectangular shoes, one on each side of the machine, as is seen in the illustration. Each shoe measures 25 ft. by 4 ft. and is suspended from an elongated cam track mounted on the rotating superstructure. A double-flanged cam or eccentric rotates inside each of the cam tracks, these cams being fitted on squared ends of a heavy travelling shaft running across the superstructure. The shaft is clutch-operated from robust gears driven from the main machinery. As each cam is rotated in the cam track driven from the shaft, a crank-pin carrying a roller travels up and down in a vertical slot in the cam frame. The action of the eccentric cam and the vertical motion of the crank pin raises and lowers the shoes and lifts and moves the machine forward when the shoes are pressed on the ground. A brake holds both shoes in the raised position when the machine is digging and is automatically released when the driving clutch is engaged. Each revolution of the cam carries the machine forward a distance of 6 ft. The walking action above described may, perhaps, be more clearly understood by reference to the illustration in vol. 145, previously mentioned, although that is not applicable in all its details to the machine now described.

The walking excavator is very mobile and can move in any direction from its original position. This ready change of direction arises from the fact that the walking shoes are attached to the rotating superstructure. The shoes, when lifted clear of the ground, can be rotated into any other position in a horizontal plane. When they are lowered again and the travelling gear is started up, the machine will progress in the direction in which the shoes are pointing. The superstructure revolves on a track of 40 double-flanged rollers, 10 in. in diameter, arranged in a circle 18 ft. in diameter. The walking gear consists of very few wearing parts, which are well above mud and dirt. We understand from Messrs. Ruston-Bucyrus that another walking drag-line excavator of the same size is in course of construction for Messrs. Midland Ironstone Company, Limited, Scunthorpe. This machine, however, has a jib 155 ft. in length and employs a 2¼-cub. yard bucket, a deeper overburden having to be dealt with. Moreover, it has a Diesel engine as a power unit instead of being electrically-driven. In all, we understand, six walking drag lines are to be used for stripping ironstone in England.

CATALOGUES.

Oil Indicators.—Messrs. Rotherham and Sons, Limited, Coventry, have sent us a folder entitled "Danger Signals," describing various types of oil indicators for visual or audible warning.

Steel Plate Batteries.—We have received from Messrs. Nife Batteries, Limited, Hunt End Works, Redditch, Worcestershire, a pamphlet describing their steel plate batteries for electric trucks, locos, etc.

Welding Materials.—We have received a leaflet from Messrs. Mallory Metallurgical Products, Limited, 78, Hatton Garden, London, E.C.1, covering their range of resistance-welding die and electrode materials.

Emergency Lighting.—Equipment for lighting air-raid shelters, hospitals and stores, in emergency, is dealt with in a catalogue issued by Messrs. Crypton Equipment, Limited, North Acton-road, Park Royal, London, N.W.10.

Electric Water Heating.—A new catalogue of equipment for water heating has been received from Messrs. The General Electric Company, Limited, Magnet House, Kingsway, London, W.C.2. Data are included for assistance in estimating for such equipment.

Portable Electric Tools.—Sanders, grinders and other portable electric tools, of American design, now manufactured by Messrs. Standard Telephones and Cables, Limited, Connaught House, Aldwych, London, W.C.2, are described in a catalogue recently sent to us by that company.

Continuous Sawing and Filing.—We have received from Messrs. Continental Machines, Inc., 1301, Washington-avenue, South Minneapolis, Minnesota, U.S.A., two circulars relating to their Doall precision saws and file bands, with notes on the selection of the correct type for particular work.

Handlamp Transformer.—Messrs. The British Thomson-Houston Company, Limited, have issued from the temporary address of their lamp-advertising department, Bridle Path, Watford Junction, Watford, Hertfordshire, a leaflet giving particulars of their handlamp transformer, which complies with Home Office regulations and eliminates the risk of accidents when hand-lamps are connected directly to mains in damp situations.

REINFORCED-CONCRETE PIT PROPS.

As a result of the war, the replacement of foreign timber by home-produced material has become urgent. Investigations have been made by the Mines Department, and a specification has been prepared covering the requirements for materials, manufacture, and tests, to ensure the supply of pit props of reinforced concrete.* A previous report, published in December, 1939, was based on the use of hand mixing and hand placing, such as might be practised on a small scale at individual collieries. Attention was subsequently drawn to the advantages of mass-production methods, as used by manufacturers of pre-cast concrete, and, following discussions with a number of manufacturers of pre-cast concrete products regarding the problems arising in the making of pit props, samples were made and submitted to tests by the Safety in Mines Research Board. These tests showed that high-grade props could be produced in quantities under normal commercial conditions.

The opening clauses of the specification follow the lines of B.S.S. No. 607-1935, "Reinforced Concrete Poles for Electrical Transmission," and are intended to secure a reasonable degree of uniformity in the product, so that samples tested shall be representative of the quality of the batch of props from which they were taken. The amount of reinforcement necessary is approximately 8 per cent. of the total weight of the prop if in mild steel, or the equivalent in high-tensile steel. Half of this is to be in the form of longitudinal rods to provide sufficient mechanical strength to allow the prop to be handled, and half in the form of a spiral to prevent sudden and violent failure. Although the circular cross-section of timber props is the most convenient in use, this shape may be difficult to produce in concrete, and the specification therefore allows for props of octagonal section, or square with chamfered corners. To reduce the number of moulds necessary, it is proposed that the whole range from 2 ft. to 6 ft. 3 in. in length should be covered by six diameters with three standard lengths to each diameter. Details of the method of laboratory testing, and of a drop test which requires no special apparatus, are given in the specification.

Pointed or chamfered ends, intended to enable the props to penetrate the floor, lead to a reduction of the strength as determined in the testing machine. Steel ferrules, $\frac{3}{4}$ in. wide by $\frac{1}{16}$ in. thick, have been employed to prevent ravelling of the ends of props when set and withdrawn repeatedly, and it is probable that pressed-steel caps would serve the same purpose even more effectively. Obviously, the use of some form of releasing device would greatly increase the usefulness of concrete props at the coal face; but this question, together with the use of steel bands or ferrules, timber or weak concrete cushion pieces, and the practical application of chamfered or pointed ends, is still under investigation, and, therefore, is not dealt with in the present specification. Nor are any rules laid down for the grading and proportioning of the raw materials to be used in making the concrete, but due care must, of course, be given to these matters if the concrete is to develop the specified strength under test. Provided that good-quality materials are available, strong concrete can be made, within limits, either by using a large quantity of cement without devoting much care to the grading of the aggregate, or by using less cement in conjunction with a well-graded aggregate. Although the latter type of concrete is preferable, it may be cheaper, where the amount required is small, to use a larger amount of cement than to sieve and grade the aggregate. The method of compacting is also of importance; harsher, but stronger, concretes can be satisfactorily compacted by vibration than can be done by hand. In the case of hand-moulded props, where wet mixes are likely to be used, a slump test has been specified. It is proposed to standardise six diameters (or the equivalent octagon or chamfered square sections) for face props, rising by $\frac{1}{2}$-in. steps from 3 in. to $5\frac{1}{2}$ in. Props of each diameter would be made in three lengths only, and thus the range of lengths from 2 ft. to 6 ft. 3 in. is covered in 3-in. steps. In this scheme, there is a standard diameter corresponding to each length of prop. The ratio of diameter to length has the value, customary for wood props, of 1 : 12 for the 4 ft. 6 in. size, shorter props being stouter, and longer props more slender. Underground trials made with props stouter than those specified are reported to have given very satisfactory results, and the suggestion has been made that the 4-in. diameter size should be used down to the 2-ft. length. A variation of this kind can be made quite easily by blanking off part of the mould. Variations in the direction of greater slenderness, however, should not be permitted. The face props are intended to have 8 per cent. of steel by weight, reckoned on the net section enclosed by the spiral.

* *Specification for Reinforced-Concrete Pit Props.* Mines Department. Obtainable, without charge, from the Director of Mining Supplies, Mill House, 87-89, Shaftesbury-avenue, London, W.1.

"ENGINEERING" ILLUSTRATED PATENT RECORD.

ABSTRACTS OF SPECIFICATIONS RECENTLY PUBLISHED UNDER THE ACTS OF 1907 TO 1939.

The number of views given in the Specification Drawings is stated in each case; where none is mentioned, the Specification is not illustrated.
Where inventions are communicated from abroad, the Names, etc., of the communicators are given in italics.
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ELECTRICAL APPARATUS.

518,315. Synchronous Motor. The General Electric Company, Limited, of London, and H. C. E. Jacoby, of Witton. (7 *Figs.*) August 22, 1938.—The invention is a squirrel-cage rotor for a small self-starting synchronous motor. The object of the invention is to provide this type of motor with a more even starting torque and a better synchronising torque, and also to allow of a required characteristic being readily obtained. The rotor 1 is laminated and carries the bars 3 of a squirrel-cage winding. Parts of the laminations between the holes

Fig. 1.

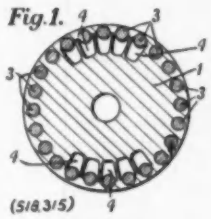
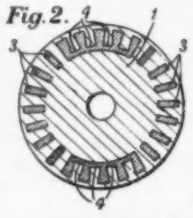


Fig. 2.



for groups of bars 3 corresponding to the poles of the motor, which is assumed to be bi-polar in the figures, are cut away towards the inner parts to form gaps 4, Fig. 1. Thus, the bars of each group are bridged by magnetic material at the outer faces, while their inner faces are separated by air, or, in motors where the bars 3 are cast integral with the end rings, the parts of the core laminations which are cut away are filled in solid with the bars, as shown in Fig. 2. By building up the rotor with interleaved laminations 1 and laminations of the normal solid type in varying proportions, it is possible to adjust the relative reluctances of the cut-away and the normal parts, and hence to vary the characteristics of the motor. (*Accepted February* 23, 1940.)

MACHINE AND OTHER TOOLS, SHAFTING, ETC.

517,850. Work-Holder for Milling Machine. Roberts Black and Company, Limited, of Manchester, and F. G. Anderson, of Manchester. (2 *Figs.*) August 12, 1938.—The work-holder is of the rotatable table type and is designed to effect a saving in production time. The base 10 is rectangular and at each end is a slotted lug by which it is bolted to the table of the milling machine. At one end of the base, beside the slotted lug, are a pair of lugs 12, between which is pivoted a lever 13 having a curved projection which forms a positioning and locating clamp. At the other end of the base is a raised

Fig. 1.

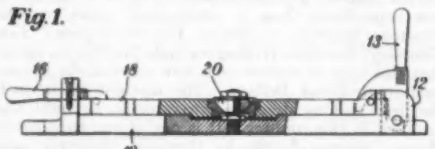
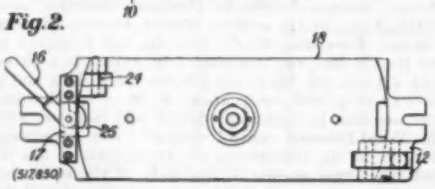


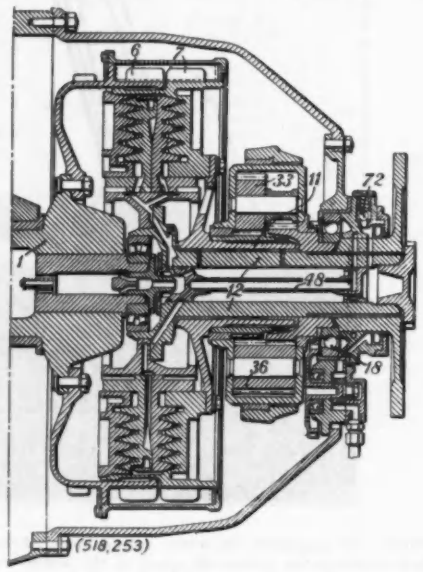
Fig. 2.



cross piece, the centre of which is slotted in the plane of the base and in which is pivoted a further clamping lever 16, the upper pivot being in a bridge piece 17. The upper surface of the base is machined to carry a rotatable top plate 18, which is partly held and located by a central pivot stud fixed in the base. This stud carries an adjustable hardened and ground cone 20, which seats in a bush fixed in the top plate 18. The top plate has tapped holes to take jigs for the parts to be milled. At opposite corners the top plate has a pair of small lugs carrying a cross pin 24 which is engaged by the curved projection of the clamp 13. At each end of the top plate is a small insert 25 with a machined top surface engaged by a cam face on the underside of the lever 16. In operation, castings are clamped on one end of the top plate. These castings are then fed to the cutters and while the work on one end of the top plate is being machined the jigs on the other end of the top plate are loaded. When the operation is complete on the first end the work is withdrawn, the top plate is unclamped, and is turned through 180 deg. so that work on the other end is opposite the cutters and equally correctly located for machining. The fitting thus enables much time to be saved. (*Accepted February* 9, 1940.)

SHIPS AND NAUTICAL APPLIANCES.

518,253. Marine-Engine Gear. Davey Paxman and Company (Colchester), Limited, and E. P. Paxman, of Colchester. (3 *Figs.*) December 9, 1938.—The object of the invention is to provide a marine-engine control gear which will transmit the drive at full engine speed when running ahead and at reduced speed when running astern, and will have a neutral position to allow for idling of the engine and for trailing the propeller freely when the engine is stopped. The end of the engine crank shaft 1 has a flange to which is bolted an annular housing carrying the driving component 6 of a flexible coupling for reducing torsional vibrations. The driven component 7 is carried on an annulus bolted to a flanged sleeve 11 running free on the hollow main shaft 12, which is coupled to the propeller shaft. The inner end of the main shaft is carried by a roller bearing mounted on the end of the crankshaft, which allows slight angular play of the shaft 12. Within the annular housing is an oil-operated clutch, the driving part being rotated by the driven member 7 of the flexible coupling. The driven clutch members



are a pair of plates with tapered annular ribs on their outer surfaces which engage grooves in the pair of driving members. The plates are forced apart by oil pressure and are integral with sleeves which slide on splines on a cylinder bolted to a flange on the inner end of the main shaft. Surrounding the sleeve 11 is a housing for a set of epicyclic pinions 33 which mesh with a central pinion on the sleeve. A second set of pinions 36 which extend the width of the casing are in mesh with the first and also with a sun gear fixed to the main shaft. A brake band can lock the housing against rotation. The engine is controlled from the bridge and in the "ahead" position oil is pumped to an inlet behind the outer bearing 18 of the main shaft, and from thence flows through a tube 48 in the hollow main shaft and via communicating ducts to the space between the driven clutch plates to engage the clutch. The main shaft then runs at engine speed. A second oil supply from the interior of the crankshaft divides on reaching the main shaft. Some of the oil passes through ducts to the spaces between the driving and driven clutch members. The rest of the oil flows through the interior of the shaft 12, some lubricating the sleeve 11, the remainder passing through a relief valve 72 into the epicyclic-gear housing. When the control is moved to any but the "ahead" position, the supply of oil to the space between the clutch plates ceases, and oil passes from the crankshaft between the driving and driven clutch parts and keeps the clutch disengaged. With the engine running, a reverse drive is then obtained through the flexible coupling to the sleeve 11, which drives the epicyclic gear, the brake locking the housing. For the "neutral" position with the engine running, the brake is released. In this position, also, when the engine is stopped, the propeller can trail freely. (*Accepted February* 21, 1940.)